



ROCKWELL INTERNATIONAL  
NORTH AMERICAN SPACE OPERATIONS  
ROCKY FLATS PLANT

# Remedial Investigation Report for High Priority Sites

## (881 Hillside Area)

### Volume VI

U.S. DEPARTMENT OF ENERGY

*Rocky Flats Plant*  
*Golden, Colorado*

1 MARCH 1988

ADMIN RECORD

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By

*[Signature]*

Date

*9/20/91*

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*6/12/90*

A-DU01-000009

## **Appendix D**

APPENDIX D

DESCRIPTION OF REMEDIAL INVESTIGATION  
FIELD ACTIVITIES

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By [Signature] [Initials]  
Date 20/91

## 1.0 INTRODUCTION

This appendix describes the remedial investigation drilling and sampling program implemented at the 881 Hillside Area during May, June, September, and October 1987. The drilling program was divided into two phases. Phase I consisted of soil sample collection from 17 boreholes and installation of seven new monitor wells to determine the nature and extent of soil and ground-water contamination. Phase I borehole and monitor well locations were tentatively identified in the CEARP Remedial Investigation Plan (DOE, 1987b). Phase II drilling and sampling was performed subsequent to submittal of the draft RI report (July 1, 1987) and consisted of soil sample collection from six boreholes and installation of twelve monitor wells. Phase II drilling locations were chosen to fill data gaps identified in the draft RI report. Drilling, soil sampling, packer testing and monitor well installation procedures are presented in the Comprehensive Source and Plume Characterization Plan (DOE, 1987a) for Rocky Flats Plant. Section 2.0 of this appendix presents the rationale for monitor well and borehole locations, and Section 3.0 discusses changes in drilling and soil sampling procedures. Section 4.0 presents ground-water and surface water sampling procedures.

## 2.0 DRILLING LOCATIONS

1987 borehole and monitor well locations are shown on Plate 4-1. Phase I drilling locations were selected to generally follow the CEARP Plan (Appendix A), and Phase II drilling locations were chosen to provide further definition of the nature and extent of contamination. Final drilling locations were selected by the Site Manager and approved by the Rockwell International CEARP Manager prior to drilling.

### 2.1 BOREHOLE LOCATIONS

Soil samples were collected from boreholes at the 881 Hillside to investigate reported Solid Waste Management Unit (SWMU) locations and to investigate soil gas contaminant plumes. According to the RI Work Plan, each reported SWMU would contain at least two sampling locations. This concept was followed during the Phase I drilling; however, some borehole locations were moved slightly to investigate detected soil gas contaminants or geophysical anomalies where they did not correspond to reported SWMUs. Presented below is a discussion of each borehole location.

#### 2.1.1 Phase I Drilling Program

Boreholes BH1-87, BH2-87, and BH3-87 are located in the vicinity of the out-of-service fuel tanks (SWMU 105), the old 881 outfall pipe (SWMU 106), and the hillside fuel oil leak (SWMU 107) as specified in the SSMP. BH1-87 is located at soil gas point 92, where high molecular counts of PCE (34,448) and TCE (38,553) were detected. TCA and DCE were also detected at this soil gas point. BH2-87 is located

due south of SWMU 106 at soil gas point 110. This location was chosen not only to investigate soil conditions downstream of the outfall but also to investigate the PCE molecular count of 305 at soil gas point 110. BH3-87 is located due south of SWMU 107 to investigate soil conditions downstream of the hillside oil leak; no volatile organics were detected by the soil gas survey at this location. BH3-87 was completed as alluvial well 2-87 after soil samples were collected.

Boreholes BH4-87, BH5-87, and BH6-87 are located in the vicinity of the oil sludge pit (SWMU 102) and the chemical burial area (SWMU 103). BH4-87 is located near soil gas point 88 where a high molecular count of PCE (68,576) was detected. This borehole was moved approximately 30 feet west of soil gas point 88 due to overhead power lines. BH5-87 is located at the reported site of SWMUs 102 and 103 at soil gas point 77. No volatile organics were detected by the soil gas survey at this location. BH6-87 was located south of BH5-87 near soil gas point 106 at the reported location of SWMU 102. A PCE count of 1541 was detected by the soil gas survey at soil gas point 106, and BH6-87 was located as close to this point as site access allowed.

Borehole BH7-87 was drilled near the reported location of the liquid dumping area (SWMU 104) at soil gas point 69, where a PCE molecular count of 205 was detected with the soil gas survey.

Boreholes BH10-87 and BH11-87 are located in the revised location of the 800 Area Radioactive Site #1 (SWMU 130). The location of SWMU 130 was revised based on field reconnaissance and a review of aerial photographs, and the two boreholes were drilled within the revised SWMU location. Borehole BH11-87 is located approximately 50 feet southwest of soil gas point 116, where a PCE molecular count

of 1,120 was detected. Borehole BH10-87 is located approximately 90 feet south of BH11-87; no volatile organics were detected by the soil gas survey at this location.

Boreholes BH12-87, BH14-87, BH9-87, BH8-87, BH13-87, BH15-87, BH16-87, and BH17-87 are located in and around the multiple solvent spill area (SWMU 119). Boreholes BH12-87 and BH14-87 are located in an area of known volatile organic ground-water contamination on the 881 Hillside. BH12-87 is located at soil gas point 39 where high molecular counts of PCE (169,155) and TCE (17,241) were detected, and BH14-87 is located approximately 30 feet south of soil gas point 37 where high PCE and TCE molecular counts of 10,010 and 132,549, respectively, were also detected. BH9-87 is located approximately 190 feet northwest of BH12-87 at soil gas point 43. This borehole was placed upgradient of the volatile organic plume detected at boreholes BH12-87 and BH14-87 to determine the northern extent of the plume. Similarly, BH8-87 is located approximately 360 feet east of BH9-87, at soil gas point 19, to determine the eastern extent of the volatile organic plume. The soil gas survey detected a PCE molecular count of 299 at this location. BH13-87 is located within the reported location of SWMU 119.1 at soil gas point 56, where a PCE molecular count of 275 was detected by the soil gas survey. Boreholes BH16-87 and BH17-87 are located at the edge of SWMU 119.2 at soil gas points 11 and 12, respectively. No volatile organics were detected with the soil gas survey at soil gas point 12. At soil gas point 11, PCE, TCA, and DCE were detected at molecular counts of 462, 659, and 819, respectively. BH15-87 was placed in the north central portion of the 881 Hillside at soil gas point 26 to investigate potential soil contamination near the top edge of the hillside. A PCE molecular count of 364 was detected at this location.

### 2.1.2 Phase II Drilling Program

One additional borehole (BH57-87) was drilled and sampled adjacent to well 9-74 to evaluate soil composition and contaminants near the southern edge of 119.1. This borehole was completed as an alluvial monitor well (43-87) to replace well 9-74 which has historically contained high levels of volatile organics. Three Phase II boreholes were drilled adjacent to or downgradient to SWMU 119.2. Boreholes BH58-87 and BH59-87 were drilled on the southeast edge of the site to assess soil contamination immediately downgradient of the SWMU, and BH61-87 was drilled at soil gas point 183 to evaluate a PCE molecular count of 114 downslope from the SWMU.

Two Phase II boreholes were drilled in the vicinity of SWMUs 105, 106, and 107. Borehole BH62-87 was drilled in the area between the four SWMUs to characterize soils near Building 881. This borehole was completed as alluvial well 51-87. Borehole BH63-87 was drilled as close to soil gas point 88 as site access allowed to evaluate the PCE molecular count of 68,576 detected at this location.

## 2.2 MONITOR WELL LOCATIONS

Seven Phase I monitor wells (four alluvial wells and three bedrock wells) were installed at the 881 Hillside Area to determine the extent, magnitude, and composition of ground water contaminants. Well locations were determined from the RI Work Plan and modified based on site access as well as geophysical and soil gas survey results. Eleven Phase II monitor wells (ten alluvial and one bedrock) were installed at



the 881 Hillside Area to define ground-water conditions and contaminant plumes. A discussion of each well location is presented below.

#### 2.2.1 Phase I Wells

Alluvial well 1-87 is located immediately west of Building 881. This well is designed to serve as an upgradient alluvial well, as alluvial ground-water flow in this area is from the north-northwest to the south-southeast.

Wells 2-87 and 3-87BR comprise the well pair located south of SWMUs 106 and 107 and the South Interceptor Ditch in the RI Work Plan. The actual well pair location was moved north of the South Interceptor Ditch to characterize ground-water conditions closer to potential contaminant sources. Well 2-87 is designed to characterize alluvial ground-water quality immediately downgradient of these areas, and well 3-87BR was completed to investigate bedrock geology and water quality near these potential sources. Soil samples were collected from well 2-87 (BH3-87) before it was completed as an alluvial well.

Wells 4-87 and 5-87BR were to comprise the well pair shown south of SWMU 130 in the RI Work Plan. Well 4-87 was placed at this location, south of well 9-74 and the volatile organic soil gas plume, to determine the downgradient extent and magnitude of volatile organics emanating from SWMU 119.1. However, bedrock well 5-87BR was moved into SWMU 119.1 to characterize bedrock geology and water quality at the source of contaminants. This well was completed in a zone of fractured claystone approximately three feet thick and an underlying sandstone approximately six feet thick. Both of these zones were water bearing at the time of drilling.

The RI Work Plan shows a third well pair south of SWMU 119.2 and north of the interceptor ditch. Well 6-87 was originally located south of SWMU 119.2 to characterize alluvial ground-water quality downgradient of that area, and a hole was drilled at that location. However, it was abandoned when no water was encountered in either the surficial materials or the subcropping sandstone. This abandoned hole is designated 6-87A on Plate 4-1. Alluvial well 6-87 was then moved into the swale where wells 1-82 and 2-82 are located. This location was chosen because both wells 1-82 and 2-82 contained water, but no geologic logs or well completion details are available for either well. Thus, well 6-87 was designed to characterize geologic conditions and provide a reliable monitoring well at this location. Bedrock well 7-87BR was moved into SWMU 119.1 and drilled to investigate saturated conditions in weathered claystone on the 881 Hillside. The hole was drilled to a total depth of 51 feet, and sandstone was encountered at 38.6 feet; however, the weathered claystone above the sandstone and the sandstone were dry at this location. Therefore, the hole was plugged with Portland Type I cement and abandoned.

Well 8-87BR was cored through a surface casing set during the 1986 site characterization program. This well was not completed in 1986 because a shallow weathered sandstone was encountered at this location, but it was sealed off by the surface casing which was seated in unweathered bedrock. Well 59-86 was drilled and completed adjacent to the surface casing in the weathered sandstone. The surface casing in hole 60-86 thus not drilled until 1987, when it was renamed 8-87BR. No deeper sandstones were encountered in this hole, but a three foot thick lignite bed was encountered from 85.0 to 88.0 feet. Well 8-87BR was completed in this water bearing lignite.

### 2.2.2 Phase II Drilling Program

Twelve additional monitor wells (eleven alluvial and one bedrock) were installed at the 881 Hillside during the Phase II drilling program. Alluvial well 43-87 (BH57-87) was installed adjacent to existing well 9-74 as its well completion details were unknown. Well 9-74 has historically contained high concentrations of tetrachloroethene (PCE).

A new well pair was also installed adjacent to SWMU 119.2. The alluvial well of the pair (44-87) is immediately downgradient (south) of the drum storage area. The bedrock well 45-87BR was completed in the first occurrence of saturated sandstone beneath the site.

Five new alluvial wells were installed south of SWMUs 130, 119.1, and 119.2 to define the extent of ground-water contamination. Well 48-87 was located west of 4-87 to define the western edge of colluvial saturation and ground-water contamination emanating from SWMU 119.1, and well 49-86 located between wells 4-87 and 6-87 to define saturated conditions on the topographic high separating the two wells. Well 50-87 is located east of 6-87 to define the eastern edge of saturation and ground-water contamination. Well 47-87 is located south (downgradient) of well 4-87 and north of the South Interceptor Ditch. Well 55-87 was installed in a Quaternary terrace south of the South Interceptor Ditch. These two alluvial wells are located to determine the downslope extent of contamination from SWMU 119.1.

Four new wells were drilled in the vicinity of SWMU 105, 106, 107, and 145 to characterize ground-water flow patterns in the area. Well 51-87 was drilled within

the area presumably drained by the Building 881 footing drain (SWMU 107) to evaluate potentiometric conditions and water quality.

Wells 52-87 (BH63-87), 53-87, and 54-87 were installed outside the drain (in plan view) again to assess potentiometric conditions and water quality adjacent to the drain and other SWMUs.

### 3.0 DRILLING AND SAMPLING PROCEDURES

Procedures for drilling, sampling, packer testing, and well installation are presented in the CEARP IGMP Sampling Plan (DOE, 1987a). Drilling activities followed the procedures set forth in the Plan except for total organic field screening of soil samples and soil sample collection for laboratory chemical analyses. Presented below is discussion of deviations from these procedures.

#### 3.1 VOLATILE ORGANIC FIELD SCREENING PROCEDURES

Total organic field screening of soil samples was performed every five feet in all boreholes except BH12-87 and BH14-87. The field geologist failed to collect field screening samples from either of these two boreholes. Seventy-five milliliters of soil was placed in an 8 ounce clear glass jar with an equal amount of distilled water. The jar was then shaken and allowed to stand for 30 minutes. The sample jars were labeled with the time, date, borehole number, sample depth and geologist's initials. After 30 minutes, a reading was taken in the headspace of the jar with a photoionization detector (PID) calibrated to benzene and a flame ionization detector (FID) calibrated to methane. The headspace readings were recorded in the field notebook.

#### 3.2 SOIL SAMPLES COLLECTION FOR LABORATORY ANALYSIS

Continuous drive samples were collected from all boreholes from ground surface to total depth. Total depth varied with the depth to bedrock; but all boreholes extended at least three feet into bedrock. The continuous samples were

initially screened with a PID, an FID, and an alpha meter as soon as the sample barrels were opened. Volatile organic field screening samples were then collected every five feet as described above. These two field screening techniques in addition to visual inspection were used to identify suspected waste sources.

### 3.2.1 Phase I Soil Sampling

Both discrete and composite samples were collected from boreholes for laboratory analyses. Figure D-1 presents the sample collection and numbering scheme used for borehole samples. Discrete samples were collected:

- 1) at a waste source as identified by direct field readings off the core either by the PID or the FID, or by the field screening technique (designated a "waste sample");
- 2) at the water table (designated a "water table sample");
- 3) in alluvium just above the alluvium/bedrock contact (designated a "contact sample"); and,
- 4) in bedrock below the alluvium/bedrock contact (designated a "bedrock sample").

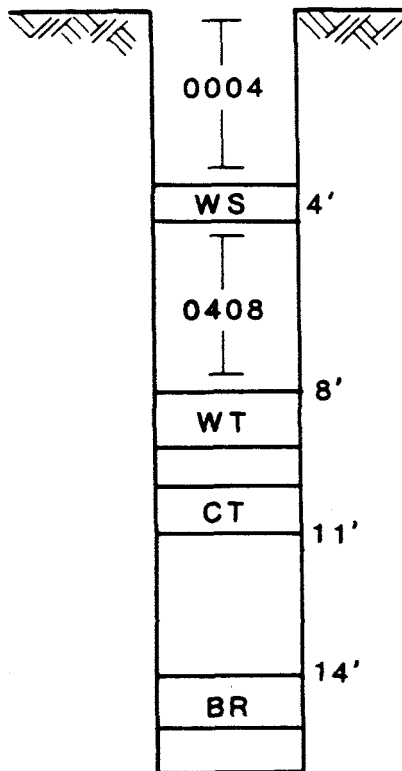
Waste sample intervals were centered around the waste source. The sample interval extended far enough from the center of the source to collect the appropriate sample volume. If field screening indicated more than one waste source in a borehole, then either the maximum field screening value was sampled or more than one waste was collected, depending on percent core recovery.

Water table samples were collected in boreholes which encountered ground water. The sample interval for these samples extended from the water table downward until the appropriate sample volume was collected.

**FIGURE D-1**  
**881 HILLSIDE AREA**  
**PHASE I**  
**BOREHOLE SAMPLE COLLECTION AND NUMBERING SCHEME**

**BH0587 0004**

Borehole    Footage  
Number



**BH05870004**

Composite sample collected from the ground surface to observed waste at four feet.

**BH058704WS**

"WS" indicates a waste sample collected based on field screening techniques. A discrete sample is centered around the waste source and the appropriate volume is collected.

**BH058704CS**

Composite sample collected from waste a four feet to water table at eight feet.

**BH058708WT**

"WT" indicates the water table sample, depth to water table is eight feet. A discrete sample is collected from the water table down, until appropriate volume is collected.

**BH058711CT**

"CT" indicates contact sample. Depth to alluvium/bedrock contact is eleven feet. A discrete sample is collected in alluvium from the contact up, until appropriate volume is collected.

**BH058714BR**

"BR" indicates the bedrock sample. A discrete sample is collected from three feet below alluvium/bedrock contact, down, until appropriate volume is collected.

Contact samples were collected from the base of surficial materials at the alluvium/bedrock contact. The sample interval extended from the base of surficial materials upward until the appropriate sample volume was collected.

Bedrock samples were collected from three feet below the alluvium/bedrock contact downward until the appropriate sample volume was collected.

Composite samples were collected from borehole intervals which were not sampled discretely. If no wastes were observed in a borehole, core was composited every ten feet to comprise a composite sample. In boreholes where a waste source was observed, composite samples were collected a maximum of every ten feet above and below the waste. Composite sample intervals varied depending on the amount of available core, the depth of the waste, the depth to water, and the depth to bedrock, as discrete samples were collected before composite samples.

### 3.2.2 Phase II Soil Sample Collection

Soil sampling procedures were modified prior to Phase II drilling at the 881 Hillside Area to reduce volatilization of organics from core before it was packaged. The new procedure described below was implemented at the East Trenches Area on August 12, 1987.

Target samples and composite samples from Phase II boreholes at the 881 Hillside were collected differently from those previously discussed. Figure D-2 presents the sample collection and numbering scheme used. Target samples were collected:

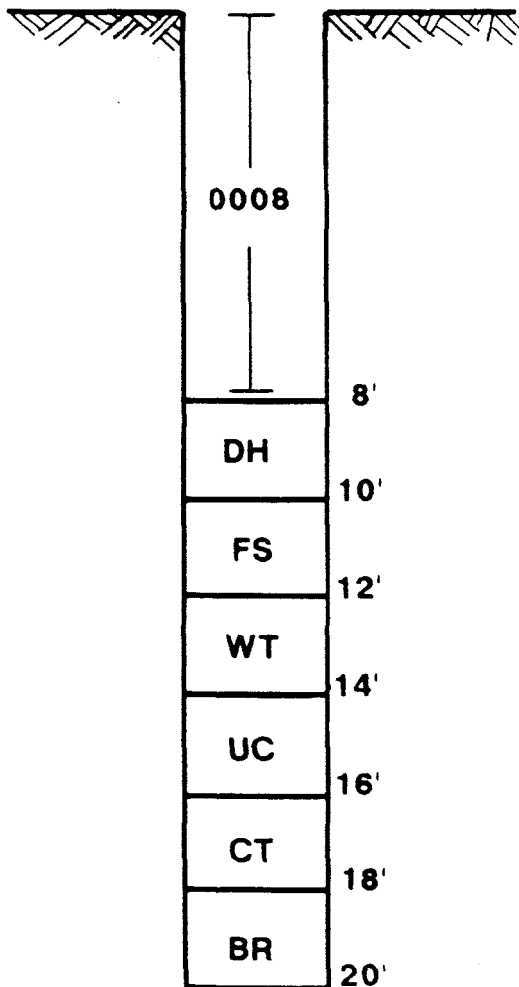
- 1) at a waste source as identified by the initial screening of the core with a PID, FID, and alpha survey meter (designated a "direct hit sample");



**FIGURE D-2**  
**881 HILLSIDE AREA**  
**PHASE II**  
**BOREHOLE SAMPLE COLLECTION AND NUMBERING SCHEME**

BH3987 0008

Borehole    Footage  
Number



**BH39870008**

Composite sample collected from the ground surface to observed waste at eight feet. VOAs submitted from six to eight foot interval.

**BH398708DH**

"DH" indicates a direct hit sample collected in the core run beginning at eight feet.

**BH398710FS**

"FS" indicates a field screen sample collected in the core run beginning at ten feet.

**BH398712WT**

"WT" indicates the water table sample. The water table was encountered in the run from 12 to 14 feet.

**BH398714UC**

"UC" indicates the upper contact sample. The sample was collected in the core run immediately above the run in which the alluvium/bedrock contact was encountered.

**BH398716CT**

"CT" indicates the contact sample. The alluvium/bedrock contact was located in the run beginning at 16 feet.

**BH398718BR**

"BR" indicates the bedrock sample. The sample was collected in the core run immediately below the run in which the alluvium/bedrock contact was encountered.

- 2) at a waste source as identified by field screening (designated a "field screen sample");
- 3) at the water table (designated a "water table sample");
- 4) in alluvium in the sample run immediately above the alluvium/bedrock contact (designated an "upper contact sample");
- 5) in the sample run containing the alluvium/bedrock contact (designated the "contact sample"); and
- 6) in bedrock in the sample run immediately below the sample run containing the alluvium/bedrock contact (designated a "bedrock sample").

After the initial screening with a PID, an FID, and an alpha meter was completed on a core interval, two four-ounce precleaned glass jars were filled with soil for volatile organic analyses (VOA). If a direct hit was recorded during the screening, then the two VOA jars were filled, followed by three eight-ounce, precleaned clear glass jars for radiochemistry, base neutral acids (BNA), pesticides, and metals analyses.

All of the target samples were collected as composite samples of each two, two and one-half, or three foot core interval. The sample run length varied slightly between the drilling rigs depending on the availability of the sampling barrels and core recovery.

Drilling and soil sampling continued in the borehole until no PID or FID direct hit or field screen readings above background were detected.

Composite samples were collected from borehole intervals of eight feet in which no target samples were collected. Three eight-ounce glass jars (for radiochemistry, BNA/pesticides, and metal analyses) were composited and the two

VOAs from the core interval nearest the base of the eight-foot interval was used to complete the composite sample.

#### 4.0 GROUND-WATER AND SURFACE WATER SAMPLING PROCEDURES

Ground-water and surface water sampling procedures implemented during this RI are presented in Appendix D-1. However, the sampling collection order was modified somewhat from the order presented in Section 6.4.2.1 of the sampling procedures. As many of the wells at Rocky Flats Plant produce small quantities of water for sampling, this modification was made to collect priority samples. Table D-2 presents the modified collection order.

Other modifications occurred during first, second, and third quarters, involving containers used for radiochemical analyses. During the first, second, and fourth quarters a four liter polyethylene cubitainer was used to collect the samples. However, this entire sample volume was not used for radiochemical analyses during the first and second quarters as discussed in Appendix G. In the third quarter, one liter polyethylene bottles were used.

During the first and second quarter sampling events, samples collected for radiochemical analyses were not filtered. However, samples for radiochemical analyses were filtered during the third and fourth quarters. Surface water samples were not filtered prior to radiochemical analyses.

TABLE D-2  
SAMPLING COLLECTION ORDER FOR RCRA AND  
REMEDIAL INVESTIGATION SURFACE WATER AND GROUND WATER

<u>Parameter</u>	<u>Container Type</u>	<u>Max. Vol.</u>	<u>Min. Vol.</u>	<u>Preservation</u>
VOA	Septum Vial	2-40 ml	1-40 ml	Cool 4°C
Pu-239	Plastic	1 Liter +	1 Liter +	Filtered 25 ml HNO <sub>3</sub>
Am-241	Plastic	1 Liter +	1 Liter +	Filtered HNO <sub>3</sub> pH<2
U-233,4,5,8	Plastic	1 Liter +	1 Liter +	Filtered HNO <sub>3</sub> pH<2
NO <sub>3</sub> <sup>-</sup>	Plastic	125 ml	50 ml	H <sub>2</sub> SO <sub>4</sub> pH<2 Cool 4°C
Metals	Glass	1 Liter	400 ml	Filtered HNO <sub>3</sub> pH<2
Cr <sup>6+</sup>	Amber glass	250 ml	250 ml	None
Sr-90	Plastic	1 Liter	600 ml	Filtered HNO <sub>3</sub> pH<2
H <sup>3</sup>	Amber glass	250 ml	125 ml	Cool 4°C
Cl <sup>-</sup> /SO <sub>4</sub> <sup>-2</sup>	Plastic	1 Liter	700 ml	Cool 4°C
TDS/Alk	Plastic	1 Liter	500 ml	Cool 4°C
Carbonate/ Bicarbonate & Total Sus- pended Solids	Plastic	1 Liter	500 ml	Cool 4°C
Gross B/ Gross A	Plastic	250 ml	150 ml	HNO <sub>3</sub> pH<2

**APPENDIX D-1**

**SAMPLING PROCEDURE FOR  
GROUND-WATER MONITORING PROGRAM**

## ROCKY FLATS PLANT

SAMPLING PROCEDURE FOR GROUND WATER  
MONITORING PROGRAM

L-6213-A

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MAY NOT BE CURRENT VERSIONDATE 11-24 1987

Author: J. A. Blair

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Effective Date: July 24, 1987This procedure contains consecutively numbered pages 1 through 33.

# DISTRIBUTION

<u>COPY</u>	<u>CUSTODIAN</u>	<u>LOCATION</u>
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2	T. H. Elmont	RF-881
3	J. A. Blair	RF-881
4	J. A. Blair	RF-881
5	T. C. Greengard	RF-T452F
6	J. Zarret	RF-564



## 1. INTRODUCTION

This procedure will be used for routine ground water monitoring at the Rocky Flats Plant. The procedure provides for:

- Equipment Decontamination
- Water Level Measurement
- Well Purging
- Field Water Quality Measurements
- Sample Collection, Bottling and Preservation
- Quality Assurance/Quality Control
- Documentation and Data Management

## 2. HAZARDS, SAFETY, AND SAFEGUARDS CONTROL

2.1 The hazards and safety of this procedure are addressed in the Operation Safety Analysis (OSA), Number 452.01 and Number 121.1.

2.1.1 Copies of OSA, 452.01, have been distributed to the following:

J. A. Blair (2) RF-881  
B. Lewis (1) RF-T452B

2.1.2 Copies of OSA 121.1 have been distributed to the following:

J. A. Blair (2) RF-881  
D. I. Hunter RF-881

2.2 The following list of acids and bases are used in preserving the samples. These will cause chemical burns upon contact with the skin or eyes. Extreme caution should be used when handling these chemicals.

2.2.1 Concentrated Sulfuric Acid ( $\text{H}_2\text{SO}_4$ ) - HMR - 3,0,2

2.2.2 Concentrated Nitric Acid ( $\text{HNO}_3$ ) - HMR - 3,0,0

2.2.3 10M Sodium Hydroxide ( $\text{NaOH}$ ) - HMR - 3,0,1

### 3. SPECIAL EQUIPMENT

3.1 Standards Lab calibrated pH meter.

3.2 Standards Lab calibrated conductivity - temperature meter.

3.3 Electric water level sounder. This device is used to measure the total depth (TD) and water level of the well. The cable is graduated to indicate the length of cable in the well.

3.4 Dedicated pump system. This consists of an air actuated bladder pump that will be dedicated to specific wells.

3.5 Bladder pump. This is used to pump wells with total depths over 50 feet and/or storage volumes of over 20 gallons.

3.6 Oil-less air compressor.

3.7 Stainless steel and teflon bailers. Some stainless steel bailers will be dedicated to specific wells. Teflon or stainless steel bailers will be used to bail wells with total depths below 50 feet and/or storage volumes under 20 gallons.

3.8 Tape measure.

3.9 Field notebook and water level notebook.

3.10 Watch.

3.11 Calculator.

3.12 Walkie-Talkie.

3.13 Voice beeper.

3.14 Brushes.

3.15 Calibrated bucket, 5 gallon or larger.

3.16 Coolers.

3.17 Blue-ice packs.

3.18 Squirt bottles.

3.19 Decon tubs.

3.20 Decon spray tanks.

#### 4. MATERIALS

##### 4.1 Chemicals and Reagents

4.1.1 Concentrated sulfuric acid ( $\text{H}_2\text{SO}_4$ ).

4.1.2 Concentrated nitric acid ( $\text{HNO}_3$ ), trace metal quality.

4.1.3 10M sodium hydroxide ( $\text{NaOH}$ ). Dissolve 400g  $\text{NaOH}$  in 800 ml deionized water in a 1 liter volumetric flask. Bring up to volume and store in 1 liter plastic bottle.

4.1.4 Deionized water.

4.1.5 Alconox Solution: Dissolve 0.5 cup of alconox powder per 3 gallon of deionized or distilled water.

4.1.6 pH Buffers: Prepare by directions on buffer bottle. One buffer should be in the 4.0-6.0 range, with the other in the 8.0-10.0 range. Place buffers in sample cooler for storage.

4.1.7 Conductivity Standard: Dissolve 0.7459 g  $\text{KCl}$  (dried for 1 hour in a  $110^\circ\text{C}$  oven) in 1 liter of deionized water. Lower the temperature of the standard by cooling in ice bath of  $10^\circ\text{C}$ . Immediately take the measurement of the standard on the laboratory calibrated conductivity meter and record value on calibration sticker on bottle of standard. Place standard in sample cooler for storage.

##### 4.2 Consumable Materials

4.2.1 Pen.

4.2.2 Polypropylene rope.

4.2.3 Plastic sheeting.

4.2.4 Surgeons gloves.

4.2.5 Neoprene gloves.

4.2.6 Tyvex coveralls.

4.2.7 Shoe coverings, or booties.

4.2.8 Sample bottles - pre-preserved in laboratory.

4.2.9 Batteries.

4.2.10 Chain-of-Custody sheets.

## 5. STANDARDIZATION AND CALIBRATION

The pH meter and conductivity temperature meter will be calibrated by the Standards Lab on a quarterly basis. The equipment should be kept clean and protected from temperature extremes.

### 5.1 Calibration of pH Buffers in the Field

Calibration will be performed before each parameter is taken during both purging and sampling of the well.

5.1.1 Turn on meter and check battery.

5.1.2 Place pH buffers from cooler into labeled plastic beakers.

5.1.3 Remove boot from electrode. Rinse electrode with deionized water.

5.1.4 Immerse bulb in lower pH buffer and adjust calibration knob to correct reading. Record reading in logbook.

5.1.5 Rinse electrode with deionized water.

5.1.6 Immerse bulb in upper pH buffer and record reading in logbook. Do not readjust calibration knob. This is simply a check of calibration.

5.1.7 Rinse bulb with deionized water.

### 5.2 Calibration of Conductivity Standard in the Field

Calibration will be performed before each parameter is taken during both purging and sampling of the well.

5.2.1 Turn on meter.

5.2.2 Place conductivity standard from cooler into labeled plastic beaker.

5.2.3 Rinse electrode with deionized water.

5.2.4 Immerse probe into standard adjust temperature compensate knob to correct standard reading. Record reading in logbook.

5.2.5 Rinse probe with deionized water.



## 6. OPERATING INSTRUCTIONS

### 6.1 Equipment Decontamination

All decontamination will be performed with one person acting as the clean person and one the dirty person. Both people will wear new clean surgeons gloves. The dirty person will handle all the equipment before cleaning, and the clean person will handle the equipment after cleaning.

6.1.1 Decontamination of the water level sounder should be performed after each reading and stored in a clean plastic bag.

After reading has been taken, decon the sounder directly out of the well. One person should wind the sound on the reel while the other person rinses it withalconox solution, followed by deionized water.

6.1.2 Decontamination of the bailer should be performed after each use unless it is to be re-used for additional purging or sampling of the same well. In such a case the bailer should be placed in a clean plastic bag and labeled for the specific well.

After use of the bailer is complete, disassemble it and decon each part, using a brush andalconox solution. Then rinse each part with deionized water and reassemble. Store the bailer in a clean plastic bag.

6.1.3 Decontamination of the portable bladder pump should be performed after each use. Decon the pump directly out of the well.

One person should wind the pump on the reel while the other person rinses it withalconox solution, followed by deionized water.

After being completely deconed, place the pump-head in a five gallon container of deionized water and pump water through to clean the inside tubing.

6.1.4 Decontamination of the sample bottles should be performed after they have been filled and labeled.

Rinse each bottle withalconox solution followed by deionized water. Place the bottles in cooler.

## 6.2 Water Level Measurement

An accurate measurement of depth to water in a well is needed to monitor seasonal fluctuations of water levels and to calculate the volume to be purged from a well before water quality sample collection.

6.2.1 Record the following in the logbook:

6.2.1.1 Well Location

6.2.1.2 Identification number

6.2.1.3 Date/Time

6.2.2 Turn on well sounder, check battery, and lower cable into well until presence of water is indicated.

6.2.3 Hold cable so thumb and index finger are touching the top of casing when probe just enters water (alarm will sound). Use the north rim of the inner casing for the depth to water reference point.

6.2.4 Raise cable until alarm stops (i.e., probe is just above water level). Lower cable until alarm sounds again. Check to see if thumb and index finger are at the same location as before. Repeat one more time for a final verification.

6.2.5 Read the measurement off the cable to the nearest half of the lowest dimension. Record the water level in the logbook.

6.2.6 Continue lowering the cable into the hole to determine the total depth (TD). When slack in the cable occurs, pull the cable up until slack is gone.

6.2.7 Hold cable the same as for water level and take measurement at the north rim of the inner casing for reference point. Repeat one more time for a final verification.

6.2.8 Read the measurement off the cable to the nearest half of the lowest dimension. Record the TD in the logbook.

6.2.9 Decon the sounder as stated in Section 6.1.1.

### 6.3 Well Purging

The water standing in the well may have different chemical characteristics than the water in the formation because of volatilization of constituents and/or charges of oxidation and pH conditions. For this reason, the water standing in the well must be removed and water representative of the formation water brought into the well before the actual sample is collected. This is known as well purging.

Purging will consist of removing a minimum of three wellbore storage volumes from high production wells and a minimum of one wellbore storage volume from low production wells. A high production well is a well from which three wellbore storage volumes can be removed in eight hours. A low production well is a well from which three wellbore storage volumes cannot be removed in eight hours due to insufficient inflow to the well from the formation.

Wellbore storage volume is the volume of water standing inside the casing, i.e., the distance between the water level and the bottom of the casing (length of the water column in the well), multiplied by the inner cross sectional area of the casing.

6.3.1 Calculate the wellbore storage volume using the formula below:

$$\text{Wellbore Storage Volume (liters)} = (\text{TD} - \text{WL}) * (\text{A})$$

WSV - well storage volumes (liters)

TD - total depth (feet)

WL - water level (feet)

A - cross sectional area of well (liters/foot)

- 0.619 for 2" well

- 1.395 for 3" well

- 2.478 for 4" well

- 5.586 for 6" well

6.3.1.1 A well is considered dry if before purging, the wellbore storage volume is below one liter calculated volume.

6.3.1.2 Multiply the wellbore storage volume by three to get the minimum volume of water to be purged from the well.

6.3.1.3 Record calculations and values for: TD, WL, WSV, and A in the field notebook. Record to 2 significant figures if value is under 10, to 3 significant figures if value is over 10, and to 4 significant figures if value is over 100.

6.3.2 Remove the appropriate number of calculated wellbore storage volumes of water from the well using the dedicated pump, dedicated bailer, or portable sampling pump. Regardless of the type of equipment used to purge the well, record the total volume purged and the time when purging begins and ends.

During purging field water quality measurements will be taken four different times. These will be spread out over the total purge volume of

three wellbore storage volumes. The field water quality measurements are described in Section 6.4. If the well appears to be going dry and all three wellbore storage purge volume will not be purged, the four field water quality measurements should be obtained within the amount purged.

6.3.3 The dedicated pump system consists of an air actuated bladder pump with downward flow checking valves on the inlet to the inside of the bladder, and on the tubing above the outlet from the inside of the bladder. Air is developed to the outside of the bladder and pressure is maintained long enough that the bladder is compressed and water inside it is forced into the discharge tubing. Water is kept from exiting the bottom of the pump by the lower check valve. The air pressure is vented to the surface through the same pressurizing tube (requiring a time dependent on length of tubing, required air pressure, and depth of submergence of the pump). Water forced into the discharge tubing is held by the upper check valve. The cycle is repeated until discharge reaches the surface and purging begins. Due to the mechanism of this purging, the discharge is delivered to the surface in cyclic slugs, but the pressurizing air is never in contact with the water. The uppercheck valve has a small diameter bypass so that water in the discharge tubing after sampling will drain back into the well and will not freeze.

When placing the dedicated pump into the well, position the screen 6"-8" off the the bottom. This will prevent plugging of the screen by silt at the bottom of the well.

6.3.3.1 Appropriate clothing and gloves need to be worn to prevent contamination of equipment and personnel. This also prevents cross contamination when traveling from one well to another.

One person will be designated as the clean person. They will wear surgeons gloves beneath Neoprene gloves. They will perform field water quality measurements and dumping of the purge bucket.

The other person will be designated as the dirty person and will handle all the down hole equipment, including the pump and compressor. They will wear white Tyvex coveralls, booties and surgeons gloves beneath Neoprene gloves.

All clothing should be removed and placed in the trash before traveling to the next well.

6.3.3.2 Attach the compressor to the pump pressure inlet on the controller. (Use oil-less compressor to protect pneumatic logic components inside the controller.)

6.3.3.3 Connect the red air hose between well cap and the pump supply on the controller.

6.3.3.4 Position the refill and discharge knobs to enter position (12 o'clock), and start the compressor. Record start time of purging in the field notebook.

6.3.3.5 Set gas pressure level to a pressure sufficient to lift the column of water in the discharge tubing plus 30 PSI, but do not exceed 125 PSI, total.

6.3.3.6 Adjust the discharge knob so that venting occurs at the end of the slug discharge.

6.3.3.7 Decrease the refill cycle time until the volume discharge in each cycle begins to decrease. If decrease is immediate, lengthen both the refill and discharge cycle times, and repeat Steps 6.3.3.5 and 6.3.3.6.

6.3.3.8 Measure volume produced in a container of known volume (e.g., plastic graduated bucket).

6.3.3.9 Continue pumping until the appropriate volume has been purged. Record four field water quality measurements during purging in the field notebook. Record time at the end of pumping and the total volume pumped in the field notebook.

6.3.4 Bailing with a teflon or stainless steel bailer will be done when either a dedicated pump does not exist, the dedicated pump is inoperable, or the wellbore storage volume is less than 75 liters for all three volumes.

6.3.4.1 Appropriate clothing and gloves need to be worn to prevent contamination of equipment and personnel. This also prevents cross contamination when traveling from one well to another.

One person will be designated as the clean person. They will wear surgeon gloves beneath Neoprene gloves. They will perform field water quality measurements and dumping of the purge bucket as well as assisting the dirty person in their bailing duties.

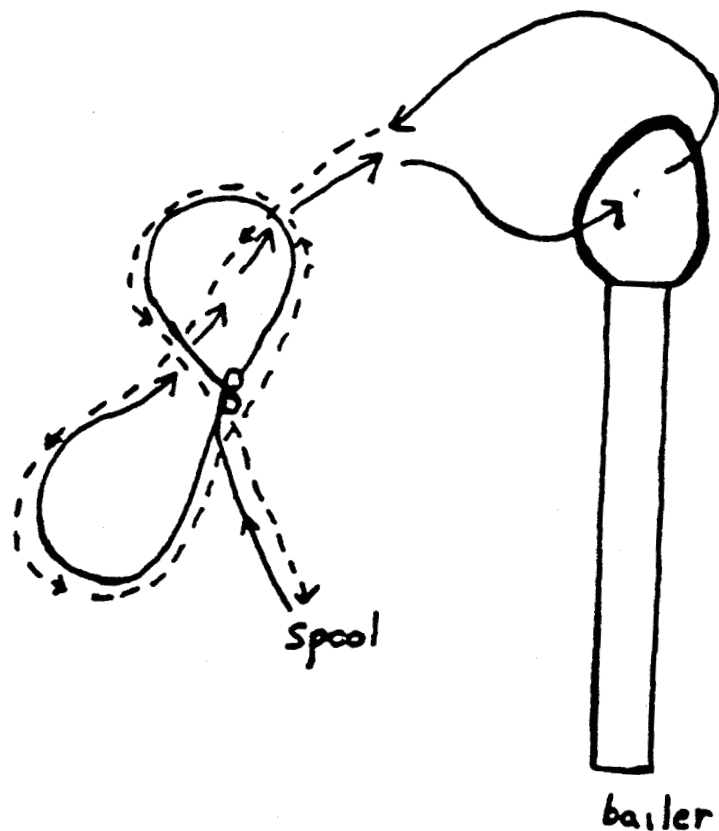
The other person will be designated as the dirty person and will remain on the plastic sheeting performing the bailing. They will wear white Tyvek coveralls, booties, and surgeon gloves beneath Neoprene gloves. Booties will be put on just prior to getting on the plastic and the person will remain on the plastic until bailing is complete.

All clothing should be removed and placed in the trash before traveling to the next hold.

6.3.4.2 Place a sheet of plastic over the casing. Cut a hole in the plastic for the casing and spread sheet on the ground around the well. The plastic and equipment should be arranged in such a manner as to enable the samplers to do all work while standing on the plastic. The plastic is to keep all equipment clean and soil free. All workers will only walk on the plastic with booties which have never touched the ground.

6.3.4.3 Remove bailer from its holder and inspect check valve, top bail, and cord which the rope ties to. (All personnel should be dressed in the appropriate clothing and gloves before handling any equipment). If any components are loose or damaged, replace them. Decontaminate equipment if any new parts are used. Do not allow bailer or rope to contact anything but clean plastic.

6.3.4.4 Tie a figure-8 knot with the rope onto the cord of the bailer. First, make a loop 6" in diameter and twist twice to form 2 small loops around base of large 6" loop with excess rope. Second, thread end of rope through 6" loop (see diagram) and out over to cord on bailer, this forms the figure 8. Third, thread end of rope through bailer cord and back through figure 8 in reverse order. Follow end of rope through along the original rope in reverse order until you have passed through the 2 small original loops around the base. This should bring the end of the rope back to the spool of rope. Pull tight.





6.3.4.5 Record start time in field notebook.

Lower bailer into well. Do not drop bailer into well at high speed because the check valve may dislodge or become damaged. Fill the bailer with water and hoist to surface coiling rope into hands or onto plastic. Pull directly up on rope when coiling. Do not allow rope to rub against casing when pulling up. Do not allow rope to fall off of plastic. If it does get contaminated the rope must be changed before bailing again.

6.3.4.6 Empty bailer into the graduated container of known volume.

Continue bailing until appropriate volume has been purged, as determined by volume in container.

Record four field water quality measurements during purging in the field notebook. Record time at the end of purging and total volume bailed in the field notebook.

Decontamination, described in Section 6.1.2, will be performed at this time.

6.3.5 A portable pump will be used to purge a well when either a dedicated pump does not exist, the dedicated pump is inoperable, or the wellbore storage volume is greater than 75 liters for all three volumes.

6.3.5.1 Appropriate clothing and gloves need to be worn to prevent contamination of equipment and personnel.

The same clean and dirty person will be established for purging with the portable pump. The same clothing will be used as designated in the previous section on bailing.

6.3.5.2 Place clean decontaminated pump approximately one foot above the bottom of the well.

Place the uphole end of the discharge in the graduated container of known volume.

Record start time for pumping in the field notebook.

6.3.5.3 Connect compressor to pump controller. Turn on compressor and pump appropriate volume as measured in graduated container.

Record four field water quality measurements during purging in the field notebook. Record time at the end of purging and total volume purged in the field notebook.

Decontamination, as described in Section 6.1.3, will be performed at this time.

#### 6.4 Field Water Quality Measurements

Calibration and standardization should be performed according to Section 5 of this procedure before each field water quality sample is taken during sampling and purging of the wells.

6.4.1 Collect sample in a beaker (rinse beaker with deionized water first).

6.4.2 Place pH probe and conductivity probe in the beaker.

6.4.3 Read pH to the nearest tenth of a pH unit. Stir the sample with the electrode to allow a stable reading. Record reading in logbook.

6.4.4 Read conductivity to two significant figures. Stir the sample with the probe to allow a stable reading. Record reading in logbook.

6.4.5 Switch to temperature. Read temperature to the nearest degree. Stir the sample with the probe to allow a stable reading. Record reading in logbook.

6.4.6 Rinse all probes and beaker with deionized water.

6.4.7 Leave meters on if more samples are to be taken, otherwise turn meters off.

#### 6.5 Sample Collection, Bottling and Preservation

For purposes of sample collection, a technically dry well is one that does not recharge sufficiently to provide at least 1 liter of sample within 24 hours of purging. A well may be sampled for partial analyses as long as at least a liter is present in the well each 24 hours. If after 24 hours the water volume is below 1 liter then the well is dry and only the partial samples will be analyzed.

Samples will be collected with the dedicated pump when possible. If a bailer or portable pump was used to purge the well then a bailer will be used to sample. The portable pumps will not be used to sample a well.

6.5.1 Preparing sample bottles will be done in the lab prior to going into the field.

Preservation and sample size for each parameter(s) will be as follows:

<u>Parameter</u>	<u>Container Type</u>	<u>Volume</u>	<u>Preservation</u>
Volatile Organics (VOA)	Septum vial	2-40 ml	Cool 4°C
Cyanide (CN <sup>-</sup> )	plastic	1-liter	10M NaOH to pH>12
Total Dissolved Solids (TDS) and Alkalinity (Alk)	plastic	1-liter	Cool 4°C
Chloride (Cl <sup>-</sup> ) and Sulfate (SO <sub>4</sub> <sup>-2</sup> )	plastic	1-liter	Cool 4°C
Metals - filtered	glass	1-liter	5 ml HNO <sub>3</sub>
Nitrate as N (NO <sub>3</sub> -N)	plastic	500 ml	H <sub>2</sub> SO <sub>4</sub> to pH<2

Pu-239	plastic	500 ml	25 ml HNO <sub>3</sub>
Tritium	amber glass	500 ml	None
Am-241	plastic	4-liter	HNO <sub>3</sub> to
U-234, 235, 238	or glass		pH<2
Sr-90			
Gross Alpha			
Gross Beta			
(RADs)			

6.5.1.1 Each sample bottle will be labeled with the following information:

Well number/sample location  
Parameter  
Date/Time sampled  
Preservation

6.5.1.2 Sample bottles will be placed in a cooler with blue ice.

6.5.1.3 Chain of Custody forms will be picked up in the lab and filled out daily in the field (Figure 1, page 33).

6.5.2 The sample should be collected immediately after purging if possible. If the well is essentially dry after purging, measure the water level in the well on a periodic basis. Collect volatile organic samples within four hours of purging. Collect the rest of the samples as soon as there is sufficient volume in the well to fill sample bottles (at least 1-liter within 24 hours). Attempt to collect an aliquot for field water quality measurements four times during sampling.

6.5.2.1 Collect samples in the following order:

VOAs  
CN<sup>-</sup>  
SO<sub>4</sub><sup>-2</sup> & Cl<sup>-</sup>  
Metals  
TDS & Alk  
NO<sub>3</sub> -N  
Pu  
Tritium  
RADs

6.5.3 The appropriate clothing and gloves need to be worn to prevent contamination of equipment and personnel. The same clean and dirty person will be established for sampling as for purging.

6.5.3.1 Take water level measurement with well sounder and record water level in field notebook.

Calculate well storage volume to determine volume available to sample.

6.5.3.2 Fill bottles according to sampling order using either a dedicated pump or bailer.

6.5.3.3 Record time of sampling and date on sample bottle and in field notebook.

6.5.3.4 When filling VOA bottles, fill each vial to overflowing with sample. Carefully place cap on the vial so that air is not captured, and tighten. Invert vial and tap lightly. If bubbles are observed, repeat process.

6.5.3.5 Metal samples are filtered with a field filter pump in the field using a prefilter followed by 0.45  $\mu$ m filter.

6.5.3.6 Complete Chain of Custody form and indicate the time, date, well number, and number of bottles sampled.

6.5.3.7 Decon sample bottles as described in 6.1.4 and place in sample cooler for trip back to lab. Samples should be delivered to lab within 4 hours of collection.

## 6.6 Quality Assurance/Quality Control

Quality Assurance/Quality Control (QA/QC) will be maintained for both field sampling activities and laboratory analyses.

6.6.1 The field sampling QA/QC program will include daily calibration of field instruments, routine maintenance of equipment, and quality control samples.

6.6.1.1 Trip blanks will be taken once per week and will consist of a full set of sample bottles filled with deionized water from the lab. These samples will be transported in coolers out to the days sampling sites and back to the lab for analysis.

6.6.1.2 Field blanks will be taken once per week and will consist of filling a full set of sample bottles in the field at a sampling site. These sample bottles are filled with deionized water and transported in coolers back to the lab for analysis.

6.6.1.3 Duplicate samples will be taken once every two weeks. These consist of a second full set of sample bottles being filled from a well currently being sampled. They will be labeled with the Well Identification-Dup and transported in coolers back to the lab for analysis.

6.6.1.4 Equipment blanks will be taken 3 times per quarter. They will consist of rinsing the equipment with deionized water (after equipment has been deconed) into a tub and then filling a full set of sample bottles with this rinse water. The samples are then transported in coolers back to the lab for analysis.

6.6.2 A maintenance log will be maintained to document equipment maintenance and calibration of instruments by the Standards Laboratory. Daily calibrations will be kept in the field notebook (See Section 6.4).

6.6.3 Field audits will be performed by personnel from the laboratory on a quarterly basis. Separate field audits will be performed by Health, Safety and Environment (HS&E) personnel on a semiannual basis.

6.6.3.1 Formal audit reports will be documented in the QA/QC files. Formal memoranda documenting deviations from the procedures in this document will be prepared and rectification will be documented by the General Laboratory management.

## 7. CALCULATIONS

7.1 Field calculations will be performed using a hand-held calculator. They will be computed and logged in the field notebook. They will include units being used and the correct number of significant figures (See Section 6.3.1).



## 8. RECORDS

All sampling activities and calibrations will be documented in the field notebook and maintenance log book. Such entries will be as descriptive and detailed as possible, so that a particular situation can be reconstructed.

Field notebooks will be bound with consecutively numbered pages. The sampling supervisor or chemist will assign a number and title to each notebook.

All entries will be made in ink. If an incorrect entry is made, the data will be crossed out with a single strike mark and initialed.

8.1 The following will be logged in the field notebook at the start of a day:

- Personnel present
- Date/Time
- Initials of person making entries
- Decontamination materials
- Weather conditions
- Equipment
- Calibration standard values

8.2 The following will be logged in the field notebook for each visit to each sampling location:

- Location and well identification
- Date/Time
- Field activity
- Comments/Observations

8.3 The following will be logged in the field notebook during purging activities:

- Device used to purge
- Start time/end time for purging
- Field parameters (i.e., pH, conductivity, temperature)
- Time for each parameter
- Water level
- Total depth
- Cross-sectional area of well
- Calculation for well storage volume

Example:

A = Cross-sectional area of well = 0.619 l/ft for 2" well

TD - Total Depth (ft)	101.4
WL - Water Level (ft)	<u>68.2</u>
	33.2 ft.

33.2 ft x 0.619 l/ft = 20.6 liters = 1 storage volume

3 storage volumes = 61.8 liters

	<u>Start</u>	<u>2nd</u>	<u>3rd</u>	<u>Final</u>
pH (S.U.)				
Conductivity ( $\mu$ mho/cm)				
Temperature ( $^{\circ}$ C)				
Time				

8.4 The following will be logged in the field notebook during sampling activities:

- Device used to sample
- Start time/end time of sampling
- Field parameters (i.e., pH, conductivity, temperature)
- Time for each parameter
- Water level
- Total depth
- Cross-sectional area of well
- Calculation for well storage volume recharged

Example:

A = Cross-sectional area of well = 0.619 l/ft for 2" well

TD - Total Depth (ft)	101.4
WL - Water Level (ft)	<u>88.2</u>
	13.2 ft.

13.2 ft x 0.619 l/ft = 8.2 liters recharge volume

	<u>Start</u>	<u>2nd</u>	<u>3rd</u>	<u>Final</u>
pH (S.U.)				
Conductivity ( $\mu$ mho/cm)				
Temperature ( $^{\circ}$ C)				
Time				

8.5 The maintenance log book will include maintenance for all calibrated field parameter instruments, pumps, compressors, bailers, well sounders, etc.

Each entry should include the following:

- Date/time sent for service
- Equipment being serviced
- Personnel doing service
- Summary of maintenance performed
- Parts needed for repair
- Calibration, if performed
- Date/time received back from service

8.6 The Chain of Custody form will be filled out in the field for each sample. It will accompany the sample to the laboratory where it will be relinquished to the laboratory sample receive person (See Figure 1, page 33).

The following entries will be filled out on the Chain of Custody:

- Samplers signatures
- Station No./Well No. (including quality control samples)
- Date/time sampled
- Composite and/or grab sample
- Station location (brief description of location)
- Number of containers
- Types of samples collected (marked by circling or X-out)
- Relinquished signature/Date/Time
- Remarks (i.e., well dry, only partial sample, sample bottle broke, etc.)

8.7 The laboratory sample receive person will log samples into the laboratory system, fill out and distribute parameter worksheets, and tag samples with lab I.D. A detailed procedure for logging in samples is outlined in "Sample Administration - General Labs", L-6002-A.

8.8 Field notebooks, maintenance notebooks, and all laboratory documentation will be kept on file within the General Labs for the current year and the previous year. The four years previous to that will be held in Records Management files on the Rocky Flats Plantsite. All records prior to the previous five years and current year will be sent to permanent storage at a designated location by Records Management.

## 9. SHUTDOWN

9.1 All equipment used in the field will be unloaded from the sample vehicle at the end of each day and stored in locked facilities.

9.2 All log notebooks, maintenance notebooks, Chain of Custody forms, etc. are returned to the laboratory office for storage overnight.

9.3 Any remaining samples are delivered to the lab at the end of the day for refrigeration and storage.

9.4 Sample vehicles are to be gassed up at the garage before the shift (7:30-8:30 am) or at the end of shift (2:30-3:30 pm).

## 10. REFERENCES

10.1 U.S. Environmental Protection Agency, 3rd Edition, November 1986, Test Methods for Evaluating Solid Waste, SW-846.

10.2 U.S. Environmental Protection Agency, 1983, Methods for Chemical Analysis of Water and Wastes, EPA-600/4-79-020.

10.3 RCRA Part B Permit Application, November 1986, U.S. DOE - Rocky Flats Plant, C07890010526.

Figure 1

[illegible]

**SAMPLING PROCEDURE FOR GROUND WATER  
MONITORING PROGRAM**

PAGE NO.  
L-6213-A-33

## **Appendix E**



**APPENDIX E**  
**HYDROGEOLOGIC DATA**

**APPENDIX E-1**  
**PRE 1986 MONITOR WELLS**

## INDEX OF DATA

Boring No.: 9-74

Completed as well? Yes

### Data in File

- ☐ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data

## WELL SUMMARY

J10K

Well Name: W-9-74

W-1-60

Elev. of Ground: \_\_\_\_\_

Elev. of Top of Casing: \_\_\_\_\_

Coordinates: \_\_\_\_\_

Date of Construction: \_\_\_\_\_

Constructed By: \_\_\_\_\_

Available Information

Geologic Log: \_\_\_\_\_

Geophysical Log: \_\_\_\_\_

Construction Details: \_\_\_\_\_

Permeability Test: \_\_\_\_\_

Water Level Data: \_\_\_\_\_

Water Quality Data: \_\_\_\_\_

23.25' 16.43  
3/21/85

7.14' 15:57 3/21/85

Condition of SurfaceInternal CasingMaterial: PVCInternal Diameter: 6"Outside Diameter: 6 1/4"Total Depth: 20.10'Stick-Up: 1.09'Condition: GOOD BUT DIRTY

A/C

5 7/8"

6 7/8"

27.78'

2.19'

GOOD, DIRTY

NONE

Protective CasingMaterial: THIN GAUGE STEELInternal Diameter: 11 7/8"Outside Diameter: 12"

Total Depth: \_\_\_\_\_

Stick-Up: 1.65'Locked: NO. 9 HINGED LIDCondition: GOODNO GRV.  
STEEL SLIP  
CAP

NONE

Surface Seal: 2'  $\phi$  CONC. CONCRETE 1" THK CONCENTRIC  
CRACKS AROUND OUTSIDE

## INDEX OF DATA

Boring No.: 10-74

Completed as well? Yes

### Data in File

- ☐ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data  
and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data

# WELL SUMMARY

J10K

Well Name: W-10-74

Elev. of Ground: \_\_\_\_\_

Elev. of Top of Casing: \_\_\_\_\_

Coordinates: \_\_\_\_\_

Date of Construction: \_\_\_\_\_

Constructed By: \_\_\_\_\_

## Available Information

Geologic Log: \_\_\_\_\_ (see page 4-5) Geophysical Log: NO

Construction Details: NO Permeability Test: NO

Water Level Data: \_\_\_\_\_ Water Quality Data: YES

7.21' @ 15:54 3/22/85

## Condition of Surface

### Internal Casing

Material: 6" NC 9 5/16" API

Internal Diameter: 6"

Outside Diameter: 6 7/8"

Total Depth: 9.96'

Stick-Up: 0.06'

Condition: GOOD DIRTY

### Protective Casing

Material: THIN GALV STEEL

Internal Diameter: 11 3/4"

Outside Diameter: 13"

Total Depth: \_\_\_\_\_

Stick-Up: 2.0'

Locked: NO HINGE LID 49 HAZARD

Condition: \_\_\_\_\_

Surface Seal: 3' of CONCR PAD BHT CRACK

ON SOUTH SIDE

## INDEX OF DATA

Boring No.: 16-74

Completed as well? Yes

### Data in File

- ☐ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☐ Water Level Data

# WELL SUMMARY

J10K

Well Name: W-16-74

Elev. of Ground: \_\_\_\_\_ Elev. of Top of Casing: \_\_\_\_\_

Coordinates: \_\_\_\_\_

Date of Construction: \_\_\_\_\_ Constructed By: \_\_\_\_\_

## Available Information

Geologic Log: \_\_\_\_\_ Geophysical Log: \_\_\_\_\_

Construction Details: \_\_\_\_\_ Permeability Test: \_\_\_\_\_

Water Level Data: ✓ Water Quality Data: \_\_\_\_\_

4.59' 10:41 3/22/85

## Condition of Surface

### Internal Casing

Material: ~~THIN GAUGE STEEL~~ PVC

Internal Diameter: 5<sup>7</sup>/<sub>8</sub>

Outside Diameter: 6<sup>1</sup>/<sub>4</sub>"

Total Depth: 5.41'

Stick-Up: 1.08'

Condition: ~~SLIGHTLY RUSTY~~ GOOD w/ SLIP CAP

### Protective Casing

Material: THIN GAUGE STEEL

Internal Diameter: 12<sup>1</sup>/<sub>16</sub>

Outside Diameter: 11<sup>5</sup>/<sub>16</sub>

Total Depth: 2.86'?

Stick-Up: 1.89'

Locked: NO HINGED LID w/ HAMP

Condition: SLIGHTLY RUSTY

Surface Seal: 2' of CONCR PAD BIG CRACKS ON SOUTH  
5' N.E. SIDES



**APPENDIX E-2**  
**1986 MONITOR WELLS**

EXPLANATION OF SYMBOLS AND TERMS  
ON BORING LOGS

SAMPLE TYPE



Split Spoon



NC Core

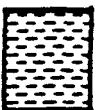


Continuous Drive

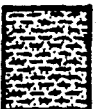


Bulk

GRAPHIC LOG



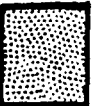
Clay or Shale



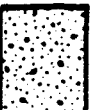
Clayey Sand or Sandy Clay



Gravel



Sand or Sandstone



Sand and Gravel



Silt or Siltstone

WATER CONTENT



WATER LEVEL FOUND DURING DRILLING



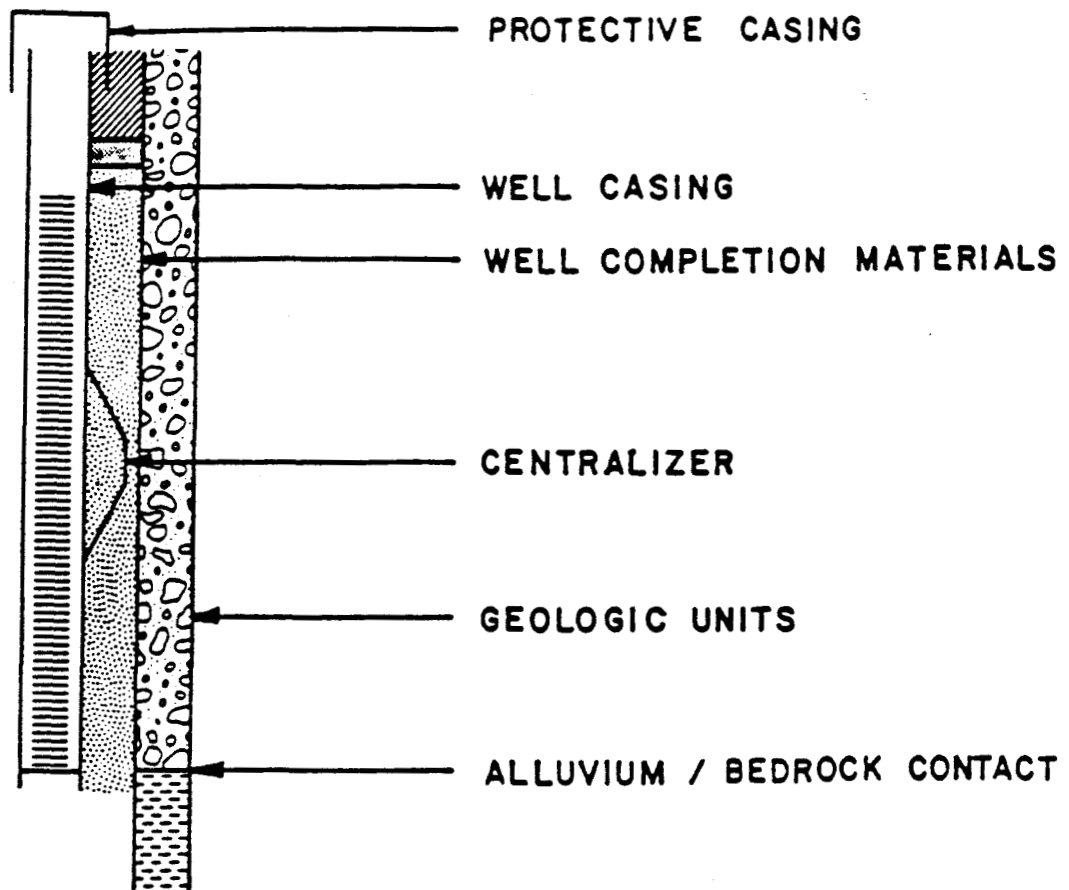
STATIC WATER LEVEL ON 10/13/88

PENETRATION RESISTANCE



STANDARD PENETRATION TEST RESULTS  
BLOWS PER INCH.

EXPLANATION OF SYMBOLS ON  
WELL CONSTRUCTION SUMMARIES



WELL CASING



BLANK



SCREEN

WELL COMPLETION MATERIALS



CEMENT GROUT



BENTONITE PELLETS



SAND PACK



CUTTINGS

GEOLOGIC MATERIALS

EXPLANATION PRESENTED IN LOG OF BORING  
EXPLANATION.

## INDEX OF DATA

Boring No.: 1-86

Completed as well? Yes

### Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data  
and Results
- ☐ Packer Test Data and Results
- ☒ Water Level Data

Project: Rocky Flats Plant

## LOG OF BORING NO.

1-86

Date Drilled 4/18/86

Coordinates N 31388.8 E 30852.2

Boring Method Hollow Stem Auger

Ground Surface Elevation 5619.14

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			VALLEY FILL ALLUVIUM					
				0-0.8'-Sample. Recovered 0.8/1.5'=53%. CLAY: dark brown; silty to sandy; granite pebble at 0.9'; poorly sorted; unconsolidated; moist.					
				1.5-3.0'-Sample. Recovered 1.1/1.5'=73%. CLAY: dark brown; silty; trace granitic granules to pebbles; caliche partings; poorly sorted; moist.					
	5			4.0-8.0'-Sample. Recovered 1.3/4.0'=33%.  4.0-7.5'. CLAY: dark brown; silty; trace granitic pebbles; moist.					
				7.5-8.0'. SAND AND GRAVEL: tan to medium brown; some clay; trace granitic cobbles; poorly sorted; wet.					
	10			8.0-13.0'-Sample. Recovered 5.0/5.0'=100%.  8.0-9.3'. SAND AND GRAVEL: medium brown; medium-grained sand to pebble sized granitic gravel; moderately well sorted; wet.					
				ARAPAHOE FORMATION					
				9.3-9.8'. CLAYSTONE: bluish gray; ferrous stains; caliche partings; weathered; wet.					
	15			9.8-10.4'. SANDSTONE: bluish gray; medium to fine-grained; clayey; quartz with mica; weathered; grades downward to yellowish brown; wet.					
				10.4-13.3'. CLAYSTONE: bluish gray to brownish; fine-grained sand stringer at 11.4'; grades downward to fine, clayey sandstone layer at 12.3-12.4'; weathered; wet.					
	20			TOTAL DEPTH: 13.3'					

Remarks

Logged by: S. Paschke

Checked by: *B.P.S.*

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 1

## WELL CONSTRUCTION SUMMARY

LOCATION or COORDS: \_\_\_\_\_

ELEVATION: GROUND LEVEL 5619.14'

N 31888.8 E 30852.2

TOP OF CASING 5620.74'

## DRILLING SUMMARY:

TOTAL DEPTH Well: 10.20' Hole: 13.30'

BOREHOLE DIAMETER 7 1/4"

DRILLER Boyles Brothers Drilling Co.

15865 W. 5th Avenue

Golden, CO (Doyle Styles)

RIG Mobile B-57

BIT(S) Blade bit

DRILLING FLUID None

SURFACE CASING 5" x 4' steel w/ locking cap

## WELL DESIGN:

BASIS: GEOLOGIC LOG ☒ GEOPHYSICAL LOG \_\_\_\_\_

CASING STRING(S): C=CASING S=SCREEN

0.00' 3.19' C1

3.19' 10.20' S1

CASING: C1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed.

SCREEN: S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0.020" wire wrap screen, 0.25' welded bottom cap.

CENTRALIZERS Centralizer placed approximately mid-point on screened interval.

FILTER MATERIAL 12-20 silica sand  
2.60' - 10.44'CEMENT Portland Type I  
0.00' - 2.00'OTHER 3/8" bentonite pellets  
2.00' - 2.60'  
10.44' - 13.30'

## CONSTRUCTION TIME LOG:

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING:	1986		1986	
7 1/4" auger	4/18	1105	4/18	1145
GEOPHYS. LOGGING:	—	—	—	—
CASING:				
2" stainless	4/18	1530	4/18	1535
FILTER PLACEMENT:	4/18	1540	4/18	1555
CEMENTING:	4/18	1555	4/18	1605
DEVELOPMENT:	8/29	1100	8/29	1100
OTHER:				
Bentonite	4/18	1531	4/18	1537
	4/18	1550	4/18	1555

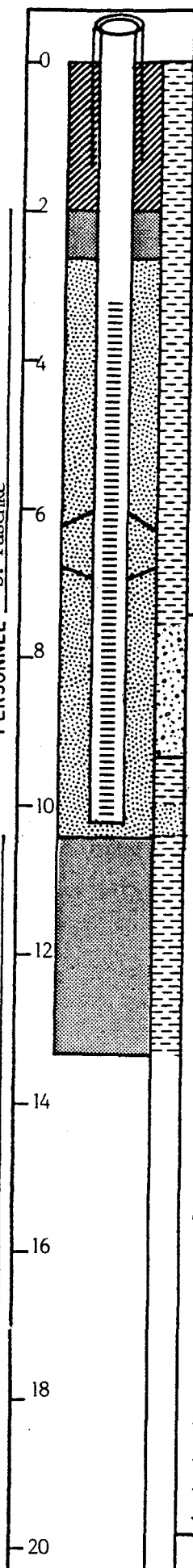
## WELL DEVELOPMENT

See Well Development Summary Sheet.

## COMMENTS:

Water encountered at 4.8' during drilling.

Top of stainless steel casing: 1.60'

LOCATION Golden, CO  
PERSONNEL S. PaschkePROJECT 106P06222  
Rocky Flats Plant

02/22/88

ROCKY FLATS PLANT  
WATER LEVEL DATA SUMMARY

WELL NUMBER	DATE	G. S. ELEVATION	TOC ELEVATION	STICK UP	SI BASE BELOW TOC	WATER DEPTH BELOW TOC	WATER SURFACE ELEVATION
0186	10/13/86	5619.14	5620.74	1.60	10.44	-1.00	DRY
	11/26/86	5619.14	5620.74	1.60	10.44	8.98	5611.76
	01/01/87	5619.14	5620.74	1.60	10.44	8.85	5611.89
	02/23/87	5619.14	5620.74	1.60	10.44	8.85	5611.89
	05/07/87	5619.14	5620.74	1.60	10.44	7.17	5613.57
	06/01/87	5619.14	5620.74	1.60	10.44	8.40	5612.34
	07/07/87	5619.14	5620.74	1.60	10.44	8.90	5611.84
	07/16/87	5619.14	5620.74	1.60	10.44	9.20	5611.54
	08/06/87	5619.14	5620.74	1.60	10.44	-1.00	DRY
	09/01/87	5619.14	5620.74	1.60	10.44	10.20	5610.54
	10/01/87	5619.14	5620.74	1.60	10.44	-1.00	DRY
	11/09/87	5619.14	5620.74	1.60	10.44	8.80	5611.94
	12/14/87	5619.14	5620.74	1.60	10.44	9.40	5611.34
	01/08/88	5619.14	5620.74	1.60	10.44	8.70	5612.04
	02/04/88	5619.14	5620.74	1.60	10.44	6.30	5614.44

## INDEX OF DATA

Boring No.: 58-86

Completed as well? Yes

### Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☒ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data  
and Results
- ☐ Packer Test Data and Results
- ☒ Water Level Data



Project: Rocky Flats Plant

# LOG OF BORING NO.


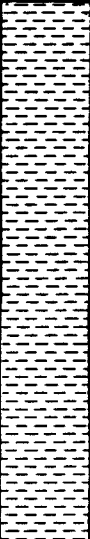
58-86

Date Drilled 9/10/86

Coordinates N 34102.8 E 20319.5

Boring Method Hollow Stem Auger

Ground Surface Elevation 5888.89

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			<p>VALLEY FILL ALLUVIUM</p> <p>0-0.6'-Sample. Recovered 0.3/0.6'=50%. GRAVEL: dusky yellowish brown (10YR 2/2); granitic pebbles and cobbles; some silty sand; poorly sorted; unconsolidated; damp.</p> <p>0.6-3.0'-Sample. Recovered 0.0/2.4'=0%. COBBLES AND BOULDERS: dry.</p>					
	5			<p>ARAPAHOE FORMATION</p> <p>3.0-4.0'-Sample. Recovered 1.0/1.0'=100%. CLAYSTONE: pale yellowish brown (10YR 6/2); silty; mottled iron staining; consolidated; damp.</p> <p>4.0-7.5'-Sample. Recovered 2.7/3.5'=77%. CLAYSTONE: pale yellowish brown (10YR 6/2); silty; mottled iron staining; consolidated; damp.</p> <p>7.5-10.0'-Sample. Recovered 2.5/2.5'=100%. CLAYSTONE: Same as above; with some organic fragments; damp.</p>					
	10			TOTAL DEPTH: 10.0'					
	15								
	20								

Remarks

Logged by: L. Pivonka

Checked by: 

Project No.  
106P06222

Hydro-Search, Inc.

Page 1 of 1

## WELL CONSTRUCTION SUMMARY

LOCATION or COORDS: \_\_\_\_\_  
N 34102.8 E 20319.5ELEVATION: GROUND LEVEL 5888.89'  
TOP OF CASING 5891.37'

## DRILLING SUMMARY:

TOTAL DEPTH Well: 3.50' Hole: 10.00'  
BOREHOLE DIAMETER 7 1/4"  
DRILLER Boyles Brothers Drilling Co.  
15865 W. 5th Avenue  
Golden, CO (Jim Horn)  
RIG Mobile B-57  
BIT(S) Blade bit  
DRILLING FLUID None  
SURFACE CASING 5" x 4' steel w/ locking cap

## WELL DESIGN:

BASIS: GEOLOGIC LOG X GEOPHYSICAL LOG \_\_\_\_\_  
CASING STRING(S): C=CASING S=SCREEN  
0.00' - 1.50' C1  
1.50' - 3.50' S1  
C1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed.  
S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0.010" wire wrap screen  
0.25' welded bottom cap.  
CENTRALIZERS Type 304 stainless steel  
2.12' - 3.29'  
FILTER MATERIAL 32-42 silica sand  
1.00' - 3.70'  
CEMENT Portland Type I  
0.00' - 0.50'  
OTHER 3/8" bentonite pellets  
0.50' - 1.00'  
3.70' - 10.00'

## CONSTRUCTION TIME LOG:

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING:	1986		1986	
7 1/4" auger	9/10	1000	9/10	1135
GEOPHYS. LOGGING:	—	—	—	—
CASING:				
2" stainless	9/6	1615	9/10	1618
FILTER PLACEMENT:	9/10	1618	9/10	1629
CEMENTING:	9/10	1632	9/10	1640
DEVELOPMENT:	9/13	1245	9/13	1245
OTHER:				
Bentonite	9/10	1629	9/10	1632
	9/10	1608	9/10	1615

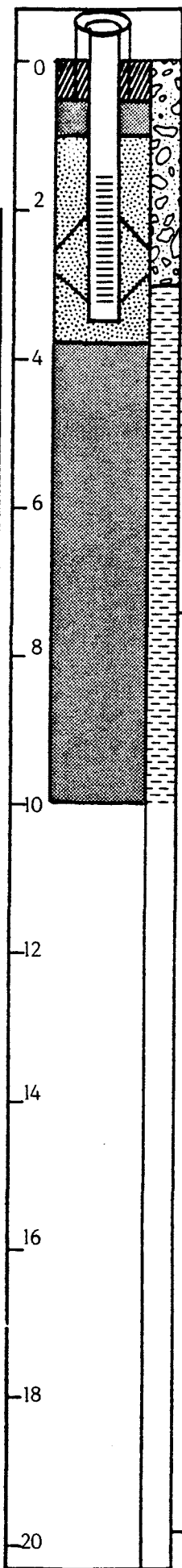
## WELL DEVELOPMENT

See Well Development Summary Sheet.

## COMMENTS:

No water encountered during drilling.

Top of stainless steel casing: 2.48'

LOCATION Golden, CO  
PERSONNEL L. PivonkaPROJECT 106P06222  
Rocky Flats Plant

WELL 58-86

**Hydro-Search, Inc.**      **Reno • Denver**

**CONSULTING HYDROLOGISTS-GEOLOGISTS**

02/22/88

ROCKY FLATS PLANT  
WATER LEVEL DATA SUMMARY

WELL NUMBER	DATE	G. S. ELEVATION	TOC ELEVATION	STICK UP	SI BASE BELOW TOC	WATER DEPTH BELOW TOC	WATER SURFACE ELEVATION
5886	09/13/86	5888.89	5891.37	2.48	5.98	-1.00	DRY
	10/13/86	5888.89	5891.37	2.48	5.98	-1.00	DRY
	11/26/86	5888.89	5891.37	2.48	5.98	-1.00	DRY
	01/01/87	5888.89	5891.37	2.48	5.98	-1.00	DRY
	05/08/87	5888.89	5891.37	2.48	5.98	5.90	5885.47
	06/02/87	5888.89	5891.37	2.48	5.98	-1.00	DRY
	06/24/87	5888.89	5891.37	2.48	5.98	-1.00	DRY
	07/07/87	5888.89	5891.37	2.48	5.98	-1.00	DRY
	07/14/87	5888.89	5891.37	2.48	5.98	-1.00	DRY
	08/06/87	5888.89	5891.37	2.48	5.98	-1.00	DRY
	10/06/87	5888.89	5891.37	2.48	5.98	-1.00	DRY
	11/09/87	5888.89	5891.37	2.48	5.98	-1.00	DRY
	12/18/87	5888.89	5891.37	2.48	5.98	-1.00	DRY
	01/09/88	5888.89	5891.37	2.48	5.98	5.90	5885.47
	02/04/88	5888.89	5891.37	2.48	5.98	5.94	5885.43

## INDEX OF DATA

Boring No.: 59-86

Completed as well? Yes

### Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☒ Well Development Summaries
- ☒ Hydraulic Conductivity Test Data  
and Results
- ☐ Packer Test Data and Results
- ☒ Water Level Data

Project: Rocky Flats Plant

## LOG OF BORING NO.

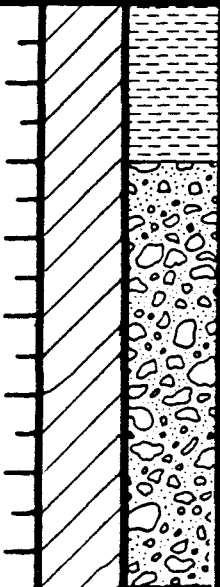
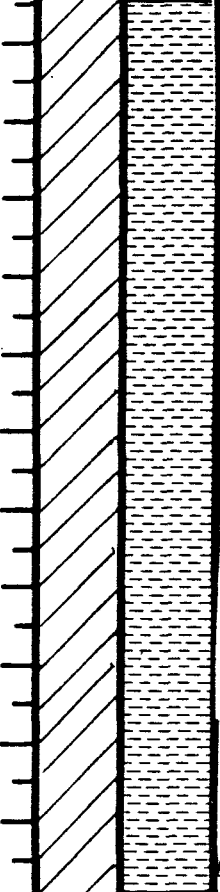
59-86

Date Drilled 9/22/86

Coordinates N 34770.4 E 21153.1

Boring Method Hollow Stem Auger

Ground Surface Elevation 5914.32

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			<p>COLLUVIUM</p> <p>0-0.5'-Sample. Recovered 0.5/0.5'=100%. CLAY:: dark yellowish brown (10YR 4/2); silty; some granitic pebbles; mottled iron staining; poorly sorted; unconsolidated; damp.</p> <p>0.5-2.0'-Sample. Recovered 1.5/1.5'=100%. CLAY: dark yellowish brown (10YR 4/2); some coarse sand; mottled iron staining; poorly sorted; unconsolidated; damp.</p> <p>2.0-5.0'-Sample. Recovered 2.5/3.0'=84%. GRAVEL: moderate yellowish brown (10YR 5/4); granitic pebbles with coarse sand; clayey; poorly sorted; unconsolidated; damp.</p>					
	5			<p>5.0-7.5'-Sample. Recovered 0.5/2.5'=25%. GRAVEL: Same as above; damp.</p> <p>ARAPAHOE FORMATION</p> <p>7.5-10.0'-Sample. Recovered 2.0/2.5'=80%. CLAYSTONE: light gray (N 7) to dark yellowish orange (10YR 6/6); weathered; consolidated; moist.</p> <p>10.0-12.5'-Sample. Recovered 1.7/2.5'=68%. CLAYSTONE: Same as above; moist.</p> <p>12.5-15.0'-Sample. Recovered 0.9/2.5'=36%. CLAYSTONE: Same as above; moist.</p> <p>15.0-17.5'-Sample. Recovered 2.3/2.5'=92%. CLAYSTONE: light olive gray (5 Y 6/1); blocky texture; some iron staining; weathered; consolidated; moist.</p> <p>17.5-19.0'-Sample. Recovered 1.0/1.5'=67%. CLAYSTONE: Same as above; moist.</p> <p>19.0-20.0'-Sample. Recovered 0.0/1.0'=80%. SANDSTONE: olive gray (5Y 6/1); clayey; some iron staining; well sorted; moist.</p>					
	10								
	15								
	20								

Remarks

Logged by: L. Pivonka

Checked by: *LLP*

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 2

Project: Rocky Flats Plant

# LOG OF BORING NO.

59-86

Date Drilled 9/22/86

Coordinates N 34770.4 E 21153.1

Boring Method Hollow Stem Auger

Ground Surface Elevation 5914.32

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20			20.0-22.5'-Sample. Recovered 2.2/2.5'=88%. SANDSTONE: Same as above; friable; moist.					
				22.5-25.0'-Sample. Recovered 2.0/2.5'=80%. SANDSTONE: Same as above; moist.					
	25			25.0-26.5'-Sample. Recovered 0.2/1.5'=33%. SANDSTONE: Same as above; moist.					
				26.5-27.5'-Sample. Recovered 0.5/1.0'=50%. CLAYSTONE: pale yellowish brown (10YR 6/2) and dark yellowish orange (10YR 6/6); silty; mottled iron staining; consolidated; moist.					
	30			27.5-30.0'-Sample. Recovered 1.0/2.5'=40%. CLAYSTONE: Same as above; moist.					
				30.0-32.5'-Sample. Recovered 0.8/2.5'=32%. CLAYSTONE: medium light gray (N 6); silty; iron staining; blocky texture; consolidated; moist.					
				TOTAL DEPTH: 32.5'					
	35								
	40								

Remarks Logged by: L. Pivonka

Checked by: *[Signature]*

Project No.

106P06222

Hydro-Search, Inc.

Page 2 of 2

## WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS: \_\_\_\_\_  
 N 34770.4 E 21153.1

 ELEVATION: GROUND LEVEL 5914.32'  
 TOP OF CASING 5915.30'

## DRILLING SUMMARY:

 TOTAL DEPTH Well: 28.00' Hole: 32.50'  
 BOREHOLE DIAMETER 7½"  
 DRILLER Boyles Brothers Drilling Co.  
 15865 W. 5th Avenue  
 Golden, CO (Jim Horn)  
 RIG Mobile B-57  
 BIT(S) Blade bit  
 DRILLING FLUID None  
 SURFACE CASING 5" x 4' steel w/ locking cap

## WELL DESIGN:

 BASIS: GEOLOGIC LOG ☒ GEOPHYSICAL LOG \_\_\_\_\_  
 CASING STRING(S): C=CASING S=SCREEN  
 0.00' 19.00' C1  
 19.00' 28.00' S1

CASING: C1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed.

 SCREEN: S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0.010" wire wrap screen  
 0.25' welded bottom cap.

 CENTRALIZERS Type 304 stainless steel  
 23.15' - 24.34'

 FILTER MATERIAL 32-42 silica sand  
 18.50' - 28.30'

 CEMENT Portland Type I  
 0.00' - 17.50'

 OTHER 3/8" bentonite pellets  
 17.50' - 18.50'  
 28.30' - 32.50'

## CONSTRUCTION TIME LOG:

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING:	1986		1986	
7½" auger	9/22	1525	9/23	1350
GEOPHYS. LOGGING:	—	—	—	—
CASING:				
2" stainless	9/23	1350	9/23	1353
FILTER PLACEMENT:	9/23	1403	9/23	1429
CEMENTING:	9/23	1440	9/23	1520
DEVELOPMENT:	9/30	1530	10/8	1230
OTHER:				
Bentonite	9/23	1429	9/23	1440
	9/23	1353	9/23	1403

## WELL DEVELOPMENT

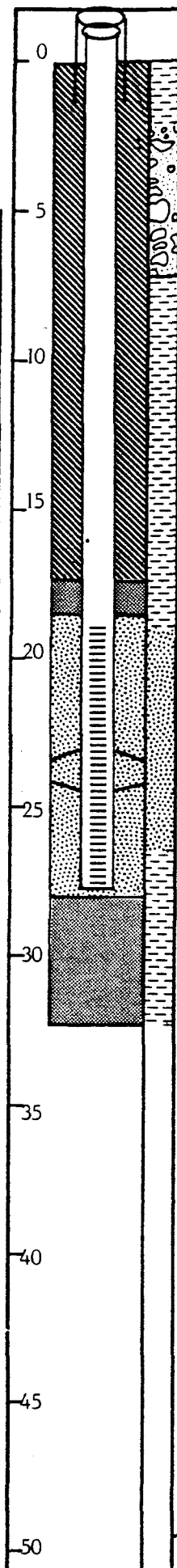
See Well Development Summary Sheet.

## COMMENTS:

Water encountered at 6.0' during drilling.

Top of stainless steel casing: 0.98'

 LOCATION Golden, CO  
 PERSONNEL L. Pivonka

 PROJECT 106P06222  
 Rocky Flats Plant




WELL 59-86

**Hydro-Search, Inc.**      Reno • Denver

CONSULTING HYDROLOGISTS-GEOLOGISTS

## AQUIFER TEST DATA

WELL 59-86

Type of Aquifer Test: Bail down - Recovery      Project No.: 106P06222  
 How Q Measured: 4.5 gallon bucket      Location: Rocky Flats Plant  
 How W.L.'s Measured: Olympic Well Scunder      Personnel: M. Bergman, J. Pearce  
 Measuring Point for W.L.'s: Top of Casing  
 Elevation of Measuring Point: 5927.5

Depth of pump/airline: N/A

Start bailing: 10/23/86      Time: 10:30:00

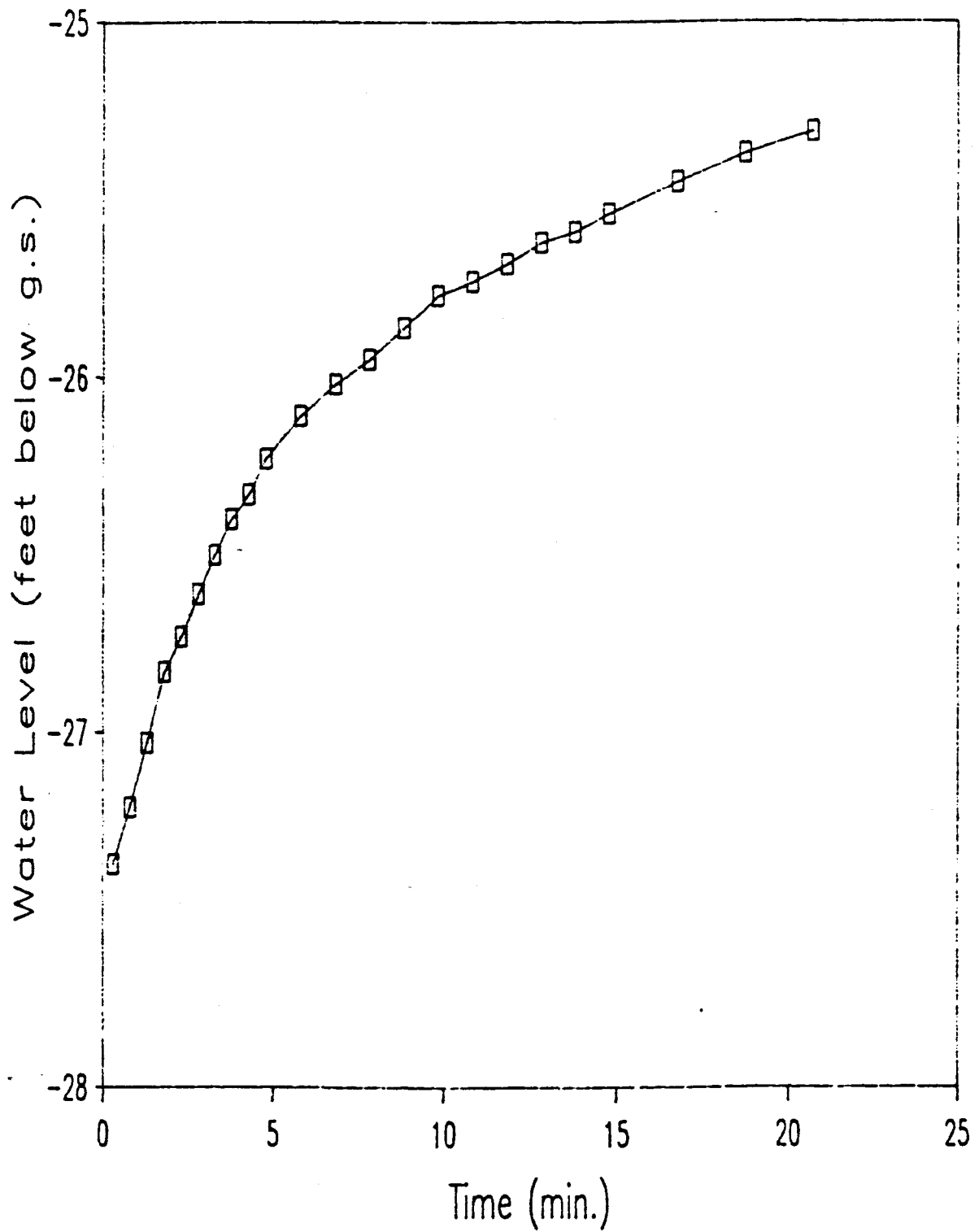
Stop bailing: 10/23/86      Time: 10:50:00

Duration of Aquifer Test: 41 minutes

TIME		WATER LEVEL DATA		COMMENTS
t = 20.2 min.	at t' = 0	Static Water Level: 25.09'		
t	t'	Water Level	Draw-down	
0				Begin bailing
20.2	0	27.45	2.37	Stop bailing
20.5	.3	27.37	2.28	Bailed 1.5 gallons
21.0	.8	27.21	2.12	
21.5	1.3	27.03	1.94	
22.0	1.8	26.95	1.74	
22.5	2.3	26.73	1.64	
23.0	2.8	26.61	1.52	
23.5	3.3	26.50	1.41	
24.0	3.8	26.40	1.31	
24.5	4.3	26.33	1.24	
25.0	4.8	26.23	1.14	
26.0	5.8	26.11	1.02	
27.0	6.8	26.02	.95	
28.0	7.8	25.95	.86	
29.0	8.8	25.86	.77	
30.0	9.8	25.77	.68	
31.0	10.8	25.70	.64	
32.0	11.8	25.68	.59	
33.0	12.8	25.62	.53	
34.0	13.8	25.59	.50	
35.0	14.8	25.54	.45	
37.0	16.8	25.45	.36	
39.0	18.8	25.37	.29	
41.0	20.8	25.31	.22	90% Recovered at 25.32'

# AQUIFER TEST DATA

WELL 59-86



02/22/88

ROCKY FLATS PLANT  
WATER LEVEL DATA SUMMARY

WELL NUMBER	DATE	G. S. ELEVATION	TOC ELEVATION	STICK UP	SI BASE BELOW TOC	WATER DEPTH BELOW TOC	WATER SURFACE ELEVATION
5986	09/30/86	5914.32	5915.30	0.98	28.98	26.68	5888.62
	10/02/86	5914.32	5915.30	0.98	28.98	26.70	5888.60
	10/03/86	5914.32	5915.30	0.98	28.98	26.67	5888.63
	10/06/86	5914.32	5915.30	0.98	28.98	26.78	5888.52
	10/07/86	5914.32	5915.30	0.98	28.98	26.78	5888.52
	10/08/86	5914.32	5915.30	0.98	28.98	26.78	5888.52
	10/13/86	5914.32	5915.30	0.98	28.98	26.80	5888.50
	10/23/86	5914.32	5915.30	0.98	28.98	25.09	5890.21
	11/26/86	5914.32	5915.30	0.98	28.98	26.08	5889.22
	01/01/87	5914.32	5915.30	0.98	28.98	25.52	5889.78
	05/07/87	5914.32	5915.30	0.98	28.98	24.25	5891.05
	06/24/87	5914.32	5915.30	0.98	28.98	26.54	5888.76
	07/06/87	5914.32	5915.30	0.98	28.98	25.20	5890.10
	08/06/87	5914.32	5915.30	0.98	28.98	24.50	5890.80
	09/02/87	5914.32	5915.30	0.98	28.98	26.00	5889.30
	10/05/87	5914.32	5915.30	0.98	28.98	26.20	5889.10
	11/09/87	5914.32	5915.30	0.98	28.98	26.30	5889.00
	12/16/87	5914.32	5915.30	0.98	28.98	26.00	5889.30
	01/09/88	5914.32	5915.30	0.98	28.98	-1.00	DRY
	02/04/88	5914.32	5915.30	0.98	28.98	25.67	5889.63

## INDEX OF DATA

Boring No.: 61-86

Completed as well? Yes

### Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data  
and Results
- ☐ Packer Test Data and Results
- ☒ Water Level Data

Project: Rocky Flats Plant

## LOG OF BORING NO. 61-86

Date Drilled 11/19/86

Coordinates N 36217.4 E 20608.7

Boring Method Hollow Stem Auger

Ground Surface Elevation 5999.31'

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Foot)		Water Content (%)		Other Tests
					20	40	20	40	
	0			ROCKY FLATS ALLUVIUM					
				0.0-2.5'-Sample. Recovered 2.0/2.5'=80%. TOP SOIL: dark yellowish brown (10YR 4/2); silty; clay-rich; abundant small cobbles and coarse gravel; disturbed; moist.					
				ARAPAHOE FORMATION					
	5			2.5-5.0'-Sample. Recovered 2.2/2.5'=88%. CLAYSTONE: yellowish gray (5Y 8/1); white (N 9/0) greasy clay with abundant CaCO <sub>3</sub> occurring throughout; some medium-grained sand in lower 1.0'; FeO stained; moist.					
	10			5.0-11.5'-Sample. Recovered 4.0/6.5'=62%. CLAYSTONE: yellowish gray (5Y 8/1); dark yellowish brown (10YR 4/2) clays, silt, sands, gravels, and small cobbles; top soil; moist; wet at 8.0' with heavy FeO stains.					
	15			11.5-13.5'-Sample. Recovered 2.0/2.0'=100%. CLAYSTONE: dark yellowish orange (10 YR 6/6); greasy; undisturbed; blocky; moist.					
				13.5-18.5'-Sample. Recovered 4.0/5.0'=80%. CLAYSTONE: dark yellowish orange (10YR 6/6); light olive gray (5Y 6/1); blocky; greasy; bedded; moist.					
				TOTAL DEPTH: 18.5'					
	20								

Remarks

Logged by: L. Pivonka

Checked by: 

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 1

## WELL CONSTRUCTION SUMMARY

LOCATION or COORDS: \_\_\_\_\_

N 36217.5 E 20608.7

ELEVATION: GROUND LEVEL 5999.31'

TOP OF CASING 6000.76'

## DRILLING SUMMARY:

TOTAL DEPTH Well: 12.25' Hole: 18.50'

BOREHOLE DIAMETER 7 1/4"

DRILLER Boyles Brothers Drilling Co.

15865 W. 5th Avenue

Golden, CO (Jim Horn)

RIG Mobile B-57

BIT(S) Blade bit

DRILLING FLUID None

SURFACE CASING 5" x 4' steel w/ locking cap

## WELL DESIGN:

BASIS: GEOLOGIC LOG X GEOPHYSICAL LOG \_\_\_\_\_

CASING STRING(S): C=CASING S=SCREEN

0.00'	5.00'	C1	_____	_____
5.00'	12.00'	S1	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

CASING: C1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed.

SCREEN: S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0.010" wire wrapped screen, 0.25' welded bottom cap.

CENTRALIZERS Type 304 stainless steel  
7.84' - 9.01'FILTER MATERIAL 32-42 silica sand  
4.00' - 12.50'CEMENT Portland Type I  
0.00' - 3.00'OTHER 3/8" bentonite pellets  
3.00' - 4.00'  
12.50' - 18.50'

## CONSTRUCTION TIME LOG:

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING:	1986		1986	
7 1/4" auger	11/19	1157	11/19	1247
GEOPHYS. LOGGING:	—	—	—	—
CASING:				
2" stainless	11/19	1429	11/19	1431
FILTER PLACEMENT:	11/19	1427	11/19	1435
CEMENTING:	11/19	1436	11/19	1447
LEVELCMENT:				
OTHER:				
Bentonite	11/19	1435	11/19	1436
	11/19	1425	11/19	1427

## WELL DEVELOPMENT

See Well Development Summary Sheet.

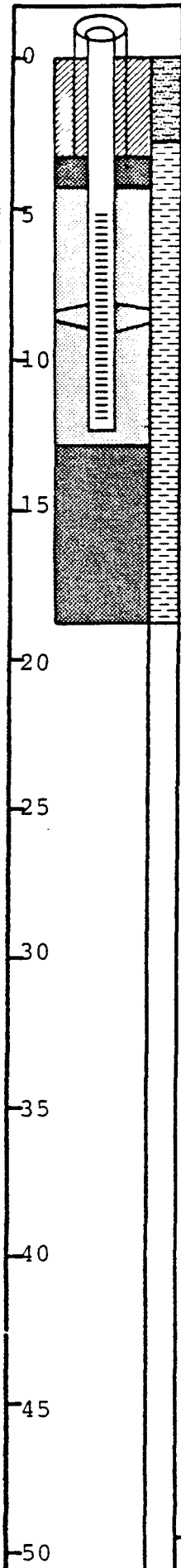
## COMMENTS:

Water encountered at 8.50' during drilling.

Top of stainless steel casing: 1.45'

LOCATION Rocky Flats Plant  
PERSONNEL L. Pivorka

PROJECT 105R06222



02/22/88

ROCKY FLATS PLANT  
WATER LEVEL DATA SUMMARY

WELL NUMBER	DATE	G. S. ELEVATION	TOC ELEVATION	STICK UP	SI BASE BELOW TOC	WATER DEPTH BELOW TOC	WATER SURFACE ELEVATION
6186	12/12/86	5999.31	6000.76	1.45	13.45	10.50	5990.26
	12/15/86	5999.31	6000.76	1.45	13.45	10.93	5989.83
	01/01/87	5999.31	6000.76	1.45	13.45	10.13	5990.63
	03/10/87	5999.31	6000.76	1.45	13.45	8.33	5992.43
	05/08/87	5999.31	6000.76	1.45	13.45	9.04	5991.72
	06/03/87	5999.31	6000.76	1.45	13.45	-1.00	DRY
	06/24/87	5999.31	6000.76	1.45	13.45	10.85	5989.91
	07/08/87	5999.31	6000.76	1.45	13.45	9.80	5990.96
	08/06/87	5999.31	6000.76	1.45	13.45	10.20	5990.56
	08/25/87	5999.31	6000.76	1.45	13.45	9.30	5991.46
	09/01/87	5999.31	6000.76	1.45	13.45	9.90	5990.86
	10/28/87	5999.31	6000.76	1.45	13.45	9.10	5991.66
	11/02/87	5999.31	6000.76	1.45	13.45	8.80	5991.96
	12/21/87	5999.31	6000.76	1.45	13.45	9.10	5991.66
	01/11/88	5999.31	6000.76	1.45	13.45	9.30	5991.46
	02/04/88	5999.31	6000.76	1.45	13.45	10.82	5989.94



02/22/88

ROCKY FLATS PLANT  
WATER LEVEL DATA SUMMARY

WELL NUMBER	DATE	G. S. ELEVATION	TOC ELEVATION	STICK UP	SI BASE BELOW TOC	WATER DEPTH BELOW TOC	WATER SURFACE ELEVATION
6486	09/13/86	5834.48	5836.46	1.98	10.98	-1.00	DRY
	10/13/86	5834.48	5836.46	1.98	10.98	-1.00	DRY
	11/26/86	5834.48	5836.46	1.98	10.98	6.98	5829.48
	01/01/87	5834.48	5836.46	1.98	10.98	7.27	5829.19
	05/08/87	5834.48	5836.46	1.98	10.98	7.02	5829.44
	06/02/87	5834.48	5836.46	1.98	10.98	9.60	5826.86
	06/24/87	5834.48	5836.46	1.98	10.98	9.50	5826.96
	07/07/87	5834.48	5836.46	1.98	10.98	-1.00	DRY
	07/16/87	5834.48	5836.46	1.98	10.98	7.70	5828.76
	08/06/87	5834.48	5836.46	1.98	10.98	10.70	5825.76
	09/02/87	5834.48	5836.46	1.98	10.98	10.60	5825.86
	10/06/87	5834.48	5836.46	1.98	10.98	10.60	5825.86
	11/09/87	5834.48	5836.46	1.98	10.98	10.50	5825.96
	12/01/87	5834.48	5836.46	1.98	10.98	9.30	5827.16
	02/04/88	5834.48	5836.46	1.98	10.98	6.94	5829.52

## INDEX OF DATA

Boring No.: 62-86

Completed as well? Yes

### Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☒ Well Development Summaries
- ☒ Hydraulic Conductivity Test Data  
and Results
- ☐ Packer Test Data and Results
- ☒ Water Level Data

Project: Rocky Flats Plant

## LOG OF BORING NO.

62-86

Date Drilled 9/25/86

Coordinates N 35154.3 E 22613.2

Boring Method Hollow Stem Auger

Ground Surface Elevation 5897.54

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			COLLUVIUM					
				0-0.5'-Sample. Recovered 0.5/0.5'=100%. CLAY: dusky yellowish brown (10YR 2/2); silty; some granitic pebbles and small cobbles; poorly sorted; unconsolidated; dry.					
				0.5-4.8'-Sample. Recovered 3.7/4.3'=86%. CLAY: dusky yellowish brown (10YR 2/2) and moderate yellowish brown (10YR 5/4); silty; trace of small granitic cobbles; poorly sorted; consolidated; damp.					
	5			4.8-7.5'-Sample. Recovered 1.6/2.7'=59%. CLAY: Same as above; damp.					
				7.5-10.5'-Sample. Recovered 3.0/3.0'=100%. CLAY: Same as above; moist.					
				10.5-12.7'-Sample. Recovered 1.3/2.2'=59%. CLAY: Same as above; moist.					
	10			12.7-14.0'-Sample. Recovered 0.6/1.3'=46%. GRAVEL: moderate brown (5YR 4/4); granitic pebbles and cobbles; some clay and sand; poorly sorted; unconsolidated; wet.					
				14.0-14.5'-Sample. Recovered 0.5/0.5'=100%. CLAY: light olive gray (5Y 6/1); mottled iron staining; unconsolidated; moist.					
	15			14.5-17.8'-Sample. Recovered 1.6/3.3'=48%. CLAY: moderate brown (5YR 4/4); silty; trace of small granitic cobbles; poorly sorted; unconsolidated; moist.					
				17.8-20.3'-Sample. Recovered 1.0/2.5'=40%. GRAVEL: moderate brown (5YR 4/4); granitic pebbles and cobbles, some sand and micaceous clay; poorly sorted; unconsolidated; wet.					
	20								

Remarks

Logged by: L. Pivonka

Checked by: *[Signature]*

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 3

Project: Rocky Flats Plant

## LOG OF BORING NO.

62-86

Date Drilled 9/25/86


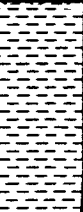

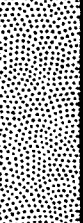
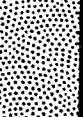
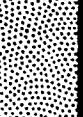
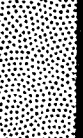
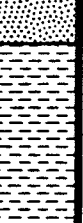
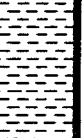

Coordinates N 35154.3

E 22613.2

Boring Method Hollow Stem Auger

Ground Surface Elevation

5897.54

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	20			20.3-22.0'-Sample. Recovered 0.9/1.7'=53%. GRAVEL: Same as above; wet.					
				ARAPAHOE FORMATION					
				22.0-22.8'-Sample. Recovered 0.3/0.8'=38%. CLAYSTONE: light olive gray (5Y 6/1) and dark yellowish orange (10YR 6/6); weathered; consolidated; moist.					
	25			22.8-25.3'-Sample. Recovered 2.0/2.5'=80%. CLAYSTONE: Same as above; moist.					
				25.3-27.8'-Sample. Recovered 1.5/2.5'=60%. SANDSTONE: light olive gray (5Y 6/1) and dark yellowish orange (10YR 6/6); weathered; well sorted; moderately well cemented; moist.					
				27.8-30.3'-Sample. Recovered 2.5/2.5'=100%. SANDSTONE: Same as above; moist.					
	30			30.3-32.8'-Sample. Recovered 2.5/2.5'=100%. SANDSTONE: Same as above; moist.					
				32.4-34.5'-Sample. Recovered 2.3/2.3'=100%. SANDSTONE: Same as above; moist.					
				34.5-35.4'-Sample. Recovered 0.9/0.9'=100%. CLAYSTONE: medium gray (N 5) and dark yellowish orange (10YR 6/6); some fine-grained sand; weathered; consolidated; damp.					
	35			35.4-37.9'-Sample. Recovered 2.5/2.5'=100%. CLAYSTONE: Same as above; damp.					
				37.9-40.4'-Sample. Recovered 2.0/2.5'=80%. CLAYSTONE: Same as above; damp.					
	40								

Remarks

Logged by: L. Pivonka

Checked by: 

Project No.

106P06222

Hydro-Search, Inc.

Page 2 of 3

Project: Rocky Flats Plant

# LOG OF BORING NO.

62-86

Date Drilled 9/25/86

Coordinates N 35154.3 E 22613.2

Boring Method Hollow Stem Auger

Ground Surface Elevation 5897.54

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	40			40.4-42.9'-Sample. Recovered 2.5/2.5'=100%. SANDSTONE: medium gray (N 5); some iron staining; plant fossils; well sorted; weathered; consolidated; damp.					
				42.9-45.4'-Sample. Recovered 2.5/2.5'=100%. SANDSTONE: Same as above; damp.					
	45			45.4-47.9'-Sample. Recovered 2.5/2.5'=100%. SANDSTONE: medium gray (N 5) and dark yellowish orange (10YR 6/6); some iron staining; plant fossils; interbedded claystone beds 1.0" thick; weathered; well sorted; consolidated; damp.					
				47.9-50.0'-Sample. Recovered 2.1/2.1'=100%. CLAYSTONE: medium gray (N 5) and dark yellowish orange (10YR 6/6); sandy; iron staining; plant fossils; weathered; consolidated; damp.					
	50			50.0-52.8'-Sample. Recovered 2.8/2.8'=100%. SANDSTONE: olive gray (5Y 4/1); fine to medium-grained; clayey; mottled iron staining; well sorted; consolidated; moist.					
				52.8-55.3'-Sample. Recovered 2.5/2.5'=100%. SANDSTONE: olive gray (5Y 4/1); medium-grained sand; clay laminae; well sorted; consolidated; moist to wet.					
	55			55.3-57.8'-Sample. Recovered 2.0/2.5'=80%. SANDSTONE: Same as above; wet.					
				57.8-59.3'-Sample. Recovered 1.5/1.5'=100%. SANDSTONE: Same as above; wet.					
	60			TOTAL DEPTH: 59.5'					

Remarks

Logged by: L. Pivonka

Checked by: 

Project No.

106P06222

Hydro-Search, Inc.

Page 3 of 3

## WELL CONSTRUCTION SUMMARY

LOCATION or COORDS: \_\_\_\_\_

N 35154.3 E 22613.2

ELEVATION: GROUND LEVEL 5897.54'

TOP OF CASING 5898.75'

## DRILLING SUMMARY:

TOTAL DEPTH Well: 35.19' Hole: 59.25'

BOREHOLE DIAMETER 7 1/4"

DRILLER Boyles Brothers Drilling Co.

15865 W. 5th Avenue

Golden, CO (Jim Horn)

RIG Mobile B-57

BIT(S) Blade bit

DRILLING FLUID None

SURFACE CASING 5" x 4' steel w/ locking cap

## WELL DESIGN:

BASIS: GEOLOGIC LOG X GEOPHYSICAL LOG \_\_\_\_\_

CASING STRING(S): C=CASING S=SCREEN

0.00' - 25.22' C1

25.22' - 35.19' S1

CASING: C1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed.

SCREEN: S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0.010" wire wrap screen  
0.25' welded bottom cap.CENTRALIZERS Type 304 stainless steel  
29.31' - 30.50'FILTER MATERIAL 32-42 silica sand  
24.00' - 35.50'CEMENT Portland Type I  
0.00' - 23.00' 37.00' - 59.30'OTHER 3/8" bentonite pellets  
23.00' - 24.00'  
35.50' - 37.00'

## CONSTRUCTION TIME LOG:

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING:	1986		1986	
7 1/4" auger	9/25	1048	10/2	1359
GEOPHYS. LOGGING:	—	—	—	—
CASING:				
2" stainless	10/2	1405	10/2	1408
FILTER PLACEMENT:	10/2	1408	10/2	1425
CEMENTING:	10/2	1615	10/2	1636
DEVELOPMENT:	10/6	1610	10/16	0940
OTHER:				
Bentonite	10/2	1425	10/2	1431
	10/2	1359	10/2	1405

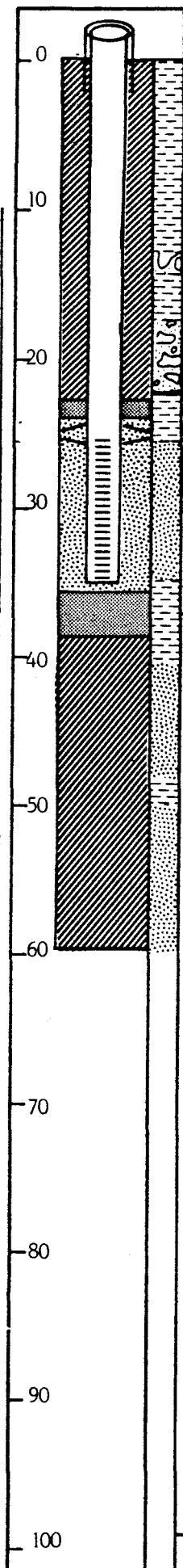
## WELL DEVELOPMENT

See Well Development Summary Sheet.

## COMMENTS:

Water encountered at 25.30' during drilling

Top of stainless steel casing: 1.21'

LOCATION Golden, CO  
PERSONNEL L. PivonkaPROJECT 106P06222  
Rocky Flats Plant

# WELL DEVELOPMENT SUMMARY

WELL 62-86

DATE	TIME	METHOD	VOLUME	APPEARANCE	COMMENTS
10-6-86	1610				1 Well Bore Volume = 1.4 gals. 10 Well Bore Volumes = 14.4 gals.
10-6-86	1610	Airlifted	1.4 gals.	Light brown mist	None
10-7-86	1530	Bailed	1.8 gals.	Light brown, slightly turbid	1.8/14.4 gals. purged to date
10-8-86	1425	Bailed	2.0 gals.	Very light brown, slightly turbid	3.8/14.4 gals. purged to date
10-9-86	1230	Bailed	2.0 gals.	Light to very light brown	5.8/14.4 gals. purged to date
10-9-86	1700	Bailed	1.5 gals.	Light brown to clear	7.3/14.4 gals. purged to date
10-10-86	0835	Bailed	2.0 gals.	Clear	9.3/14.4 gals. purged to date
10-10-86	1100	Bailed	1.5 gals.	Clear, slightly turbid	10.8/14.4 gals. purged to date
10-10-86	1540	Bailed	2.0 gals.	Clear, slightly turbid	12.8/14.4 gals purged to date
10-14-86	1045	Bailed	2.0 gals.	Clear, slightly turbid	14.8/14.4 gals. purged to date
10-15-86	1040	Bailed	2.0 gals.	Clear, slightly turbid	16.8/14.4 gals. purged to date
10-16-86	0940	Bailed	—	Clear, slightly turbid	Sampled

PROGRAM SLUGT, VERSION 4, OCT. 1985

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

- (1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3, NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")
- (2) METHOD OF BOUMER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

PROJECT NO.: 6-0118-87

CLIENT: Rockwell International

ITE LOCATION: Rocky Flats Plant

DATE OF SLUG TEST: 10-15-87

FIELD INVESTIGATOR: Kevin McNeill

WELL NO.: 62-86

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES

LENGTH OF SCREEN OR INTAKE PORTION = 9.97 FEET

INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES

DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 10.92 FEET

DIAMETER OF DRILLED HOLE = 7.25 INCHES

THICKNESS OF SATURATED AQUIFER ZONE = 10.23 FEET

ESTIMATED POROSITY OF GRAVEL PACK = .25

FALLING-HEAD INDEX = 0 ("1" IF FALLING, "0" IF RISING)

NUMBER OF HEAD-TIME DATA POINTS = 42

TIME (sec )	HEAD (FEET)
1.00	.840
2.00	.840
3.00	.840
4.00	.830
5.00	.830
6.00	.830
7.00	.830
8.00	.830
9.00	.820
10.00	.820
11.00	.820
12.00	.820
13.00	.820
14.00	.820
15.00	.810
16.00	.810
17.00	.810
18.00	.810
19.00	.810
20.00	.810
52.00	.800
82.00	.790
112.00	.780
172.00	.770
232.00	.750
292.00	.740



352.00	.730
412.00	.720
472.00	.710
532.00	.700
652.00	.690
772.00	.670
892.00	.660
1042.00	.640
1222.00	.620
1402.00	.600
1582.00	.590
1762.00	.570
1942.00	.560
2122.00	.550
2302.00	.540
2542.00	.520

HO WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED  
VALUES FOR HO  
(FEET)

.8101  
.8112

\*\*\*\*\*

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY =  $1.88\text{E-}07$  FT/sec =  $5.73\text{E-}06$  CM/sec

TRANSMISSIVITY =  $1.92\text{E-}06$  FT\*\*2/sec

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY =  $2.64\text{E-}07$  FT/sec =  $8.03\text{E-}06$  CM/sec

TRANSMISSIVITY =  $2.70\text{E-}06$  FT\*\*2/sec

02/22/88

ROCKY FLATS PLANT  
WATER LEVEL DATA SUMMARY

WELL NUMBER	DATE	G. S. ELEVATION	TOC ELEVATION	STICK UP	SI BASE BELOW TOC	WATER DEPTH BELOW TOC	WATER SURFACE ELEVATION
6286	10/06/86	5897.54	5898.75	1.21	36.40	27.90	5870.85
	10/07/86	5897.54	5898.75	1.21	36.40	27.91	5870.84
	10/08/86	5897.54	5898.75	1.21	36.40	27.98	5870.77
	10/10/86	5897.54	5898.75	1.21	36.40	28.00	5870.75
	10/13/86	5897.54	5898.75	1.21	36.40	27.83	5870.92
	10/14/86	5897.54	5898.75	1.21	36.40	27.89	5870.86
	10/15/86	5897.54	5898.75	1.21	36.40	28.03	5870.72
	10/16/86	5897.54	5898.75	1.21	36.40	27.99	5870.76
	11/26/86	5897.54	5898.75	1.21	36.40	27.92	5870.83
	01/01/87	5897.54	5898.75	1.21	36.40	27.96	5870.79
	05/07/87	5897.54	5898.75	1.21	36.40	27.83	5870.92
	06/02/87	5897.54	5898.75	1.21	36.40	27.10	5871.65
	06/24/87	5897.54	5898.75	1.21	36.40	27.16	5871.59
	07/06/87	5897.54	5898.75	1.21	36.40	26.50	5872.25
	08/06/87	5897.54	5898.75	1.21	36.40	26.00	5872.75
	09/02/87	5897.54	5898.75	1.21	36.40	25.80	5872.95
	10/05/87	5897.54	5898.75	1.21	36.40	25.70	5873.05
	11/09/87	5897.54	5898.75	1.21	36.40	26.00	5872.75
	12/01/87	5897.54	5898.75	1.21	36.40	25.90	5872.85
	12/16/87	5897.54	5898.75	1.21	36.40	25.90	5872.85
	01/08/88	5897.54	5898.75	1.21	36.40	26.30	5872.45
	02/04/88	5897.54	5898.75	1.21	36.40	26.50	5872.25

## INDEX OF DATA

Boring No.: 63-86

Completed as well? Yes

### Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☒ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☒ Water Level Data

Project: Rocky Flats Plant

## LOG OF BORING NO.

63-86

Date Drilled 9/26/86

Coordinates N 35156.0 E 22641.5

Boring Method Hollow Stem Auger

Ground Surface Elevation 5896.55

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			COLLUVIUM					
				0-0.5'-Sample. Recovered 0.5/0.5'=100%. CLAY: dusky yellowish brown (10YR 2/2); silty; some small granitic cobbles; poorly sorted; unconsolidated; damp.					
				0.5-3.8'-Sample. Recovered 0.4/3.3'=12%. CLAY: dark yellowish orange (10YR 6/6); silty; trace granitic pebbles; poorly sorted; unconsolidated; damp.					
	5			3.8-5.8'-Sample. Recovered 1.0/2.0'=50%. CLAY: Same as above; damp.					
				5.8-7.3'-Sample. Recovered 1.5/1.5'=100%. CLAY: Same as above; moist.					
				7.3-9.8'-Sample. Recovered 1.2/2.5'=48%. CLAY: Same as above; moist.					
	10			9.8-12.3'-Sample. Recovered 2.0/2.5'=80%. CLAY: Same as above; moist.					
				12.3-14.2'-Sample. Recovered 1.5/2.0'=80%. CLAY: Same as above; moist.					
				14.8-17.3'-Sample. Recovered 2.5/2.5'=100%.					
	15			14.4-14.8'. GRAVEL: moderate yellowish brown (10YR 5/4) and grayish orange (10YR 7/4); granitic pebbles and cobbles; sandy; poorly sorted; unconsolidated; moist to wet.					
				ARAPAHOE FORMATION					
				14.8-17.3'. CLAYSTONE: light olive gray (5Y 6/1); mottled iron staining; consolidated; moist.					
	20			TOTAL DEPTH: 17.3'					

Remarks

Logged by: L. Pivonka

Checked by: 

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 1

## WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS: \_\_\_\_\_  
 N 35156.0 E 22641.5

 ELEVATION: GROUND LEVEL 5896.55'  
 TOP OF CASING 5897.48'

## DRILLING SUMMARY:

 TOTAL DEPTH Well: 15.50' Hole: 17.30'  
 BOREHOLE DIAMETER 7 1/4"  
 DRILLER Boyles Brothers Drilling Co.  
 15865 W. 5th Avenue  
 Golden, CO (Jim Horn)  
 RIG Mobile B-57  
 BIT(S) Blade bit  
 DRILLING FLUID None  
 SURFACE CASING 5" x 4' steel w/ locking cap

## WELL DESIGN:

 BASIS: GEOLOGIC LOG ☒ GEOPHYSICAL LOG \_\_\_\_\_  
 CASING STRING(S): C=CASING S=SCREEN  

0.00'	3.80'	C1	-
3.80'	15.25'	S1	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-
-	-	-	-

 CASING: C1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed.  
 SCREEN: S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0.010" wire wrap screen, 0.25' welded bottom cap.  
 CENTRALIZERS Type 304 stainless steel  
 8.93' - 10.15'  
 FILTER MATERIAL 32-42 silica sand  
 3.00' - 15.80'  
 CEMENT Portland Type I  
 0.00' - 2.00'  
 OTHER 3/8" bentonite pellets  
 2.00' - 3.00'  
 15.80' - 17.30'

## CONSTRUCTION TIME LOG:

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING:	1986		1986	
7 1/4" auger	9/26	1630	9/29	1205
GEOPHYS. LOGGING:	—	—	—	—
CASING:				
2" stainless	9/29	1221	9/29	1223
FILTER PLACEMENT:	9/29	1223	9/29	1235
CEMENTING:	9/29	1237	9/29	1240
DEVELOPMENT:	10/6	1610	10/6	1610
OTHER:				
Bentonite	9/29	1220	9/29	1221
	9/29	1235	9/29	1237

## WELL DEVELOPMENT

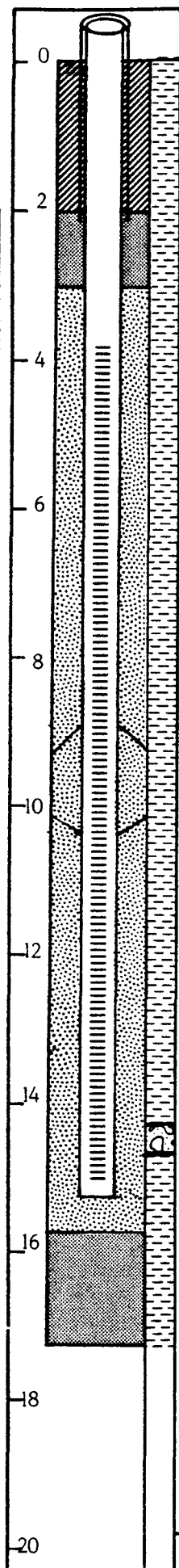
See Well Development Summary Sheet.

## COMMENTS:

Water encountered at 14' during drilling.

Top of stainless steel casing: 0.93'

 LOCATION Golden, CO  
 PERSONNEL L. Pivonka

 PROJECT 106P06222  
 Rocky Flats Plant


WELL 63-86

[illegible]

02/22/88

ROCKY FLATS PLANT  
WATER LEVEL DATA SUMMARY

WELL NUMBER	DATE	G. S. ELEVATION	TOC ELEVATION	STICK UP	SI BASE BELOW TOC	WATER DEPTH BELOW TOC	WATER SURFACE ELEVATION
6386	10/06/86	5896.55	5897.48	0.93	16.18	-1.00	DRY
	10/13/86	5896.55	5897.48	0.93	16.18	-1.00	DRY
	11/26/86	5896.55	5897.48	0.93	16.18	-1.00	DRY
	01/01/87	5896.55	5897.48	0.93	16.18	-1.00	DRY
	05/07/87	5896.55	5897.48	0.93	16.18	-1.00	DRY
	06/02/87	5896.55	5897.48	0.93	16.18	-1.00	DRY
	06/24/87	5896.55	5897.48	0.93	16.18	-1.00	DRY
	07/06/87	5896.55	5897.48	0.93	16.18	-1.00	DRY
	08/06/87	5896.55	5897.48	0.93	16.18	-1.00	DRY
	09/02/87	5896.55	5897.48	0.93	16.18	-1.00	DRY
	10/05/87	5896.55	5897.48	0.93	16.18	-1.00	DRY
	11/09/87	5896.55	5897.48	0.93	16.18	-1.00	DRY
	12/01/87	5896.55	5897.48	0.93	16.18	-1.00	DRY
	12/16/87	5896.55	5897.48	0.93	16.18	-1.00	DRY
	01/08/88	5896.55	5897.48	0.93	16.18	-1.00	DRY
	02/04/88	5896.55	5897.48	0.93	16.18	-1.00	DRY

## INDEX OF DATA

Boring No.: 64-86

Completed as well? Yes

### Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☒ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data  
and Results
- ☐ Packer Test Data and Results
- ☒ Water Level Data



Project: Rocky Flats Plant

## LOG OF BORING NO.

64-86

Date Drilled 9/10/86

Coordinates N 34683.8 E 22497.3

Boring Method Hollow Stem Auger

Ground Surface Elevation 5834.48

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			VALLEY FILL ALLUVIUM					
				0-2.0'-Sample. Recovered 2.0/2.0'=100%. GRAVEL: grayish brown (5YR 3/2); granite and quartzite pebbles and cobbles; some silty and sand; poorly sorted; angular to subrounded; unconsolidated; dry.					
	2			3.0'-Cuttings. GRAVEL: Same as above; dry.					
				3.3-4.0'-Sample. Recovered 0.7/1.7'=41%. GRAVEL: Same as above; dry.					
				4.0-6.0'-Sample. Recovered 2.0/2.0'=100%. GRAVEL: pale brown (5YR 5/2); granite and quartzite pebbles and cobbles; some silt and sand; grades downward into yellowish gray (5Y 7/2) silty sand; angular; unconsolidated; dry.					
	4								
	6								
				6.0-8.0'-Sample. Recovered 0.6/2.0'=30%. GRAVEL: moderate yellowish brown (10YR 5/4); granite and quartzite pebbles and cobbles; sandy to clayey; poorly sorted; unconsolidated; angular; dry.					
	8								

Remarks Logged by: J. Bergman

Checked by: *[Signature]*Project No.  
106P06222

Hydro-Search, Inc.

Page 1 of 2

Project: Rocky Flats Plant

## LOG OF BORING NO.

64-86

Date Drilled 9/10/86

Coordinates N 34683.8 E 22497.3

Boring Method Hollow Stem Auger

Ground Surface Elevation 5834.48

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	8			8.0-10.0'-Sample. Recovered 2.0/2.0'=100%.					
				8.0-8.8'. CLAY: greenish gray (5GY 6/1) and moderate yellowish brown (10YR 5/4); trace granitic pebbles; poorly sorted; unconsolidated; dry.					
				ARAPAHOE FORMATION					
	10			8.8-10.0'. CLAYSTONE: greenish gray (5GY 6/1) and moderate yellowish brown (10YR 5/4); homogenous; some black organic fragments; consolidated; dry.					
				10.0-12.0'-Sample. Recovered 2.0/2.0'=100%.					
				CLAYSTONE: moderate yellowish brown (10YR 5/4) with some greenish gray (5GY 6/1) clay; homogenous; consolidated; dry.					
	12			12.0-14.0'-Sample. Recovered 2.0/2.0'=100%.					
				CLAYSTONE: moderate yellowish brown (10YR 5/4) with some greenish gray (5GY 6/1) clay; homogenous; consolidated; dry.					
	14			TOTAL DEPTH: 14.0'					
	16								

Remarks

Logged by: J. Bergman

Checked by: 

Project No.

106P06222

Hydro-Search, Inc.

Page 2 of 2

## WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS: \_\_\_\_\_  
 N 34683.8 E 22497.3

 ELEVATION: GROUND LEVEL 5834.48'  
 TOP OF CASING 5836.46'

## DRILLING SUMMARY:

TOTAL DEPTH Well: 9.00' Hole: 14.00'

BOREHOLE DIAMETER 7 1/4"

DRILLER Boyles Brothers Drilling Co.

15865 W. 5th Avenue

Golden, CO (Tony Robinson)

RIG Acker

BIT(S) T5

DRILLING FLUID None

SURFACE CASING 5" x 4' steel w/ locking cap

## WELL DESIGN:

BASIS: GEOLOGIC LOG ☒ GEOPHYSICAL LOG \_\_\_\_\_

CASING STRING(S): C=CASING S=SCREEN

0.00' 3.41' C1

3.41' - 9.00' S1

CASING: C1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed.

SCREEN: S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0.010" wire wrap screen  
0.25' welded bottom cap.CENTRALIZERS Type 304 stainless steel  
4.81' - 6.31'FILTER MATERIAL 32-42 silica sand  
2.50' - 9.25'CEMENT Portland Type I  
0.00' - 2.00'OTHER 3/8" bentonite pellets  
2.00' - 2.50'  
9.25' - 14.00'

## CONSTRUCTION TIME LOG:

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING:	1986		1986	
7 1/4" auger	9/10	1130	9/10	1330
GEOPHYS. LOGGING:	—	—	—	—
CASING:				
2" stainless	9/10	1515	9/10	1520
FILTER PLACEMENT:	9/10	1520	9/10	1525
CEMENTING:	9/10	1535	9/10	1545
DEVELOPMENT:	9/13	1215	9/13	1215
OTHER:				
Bentonite	9/10	1525	9/10	1530
	9/10	1510	9/10	1515

## WELL DEVELOPMENT

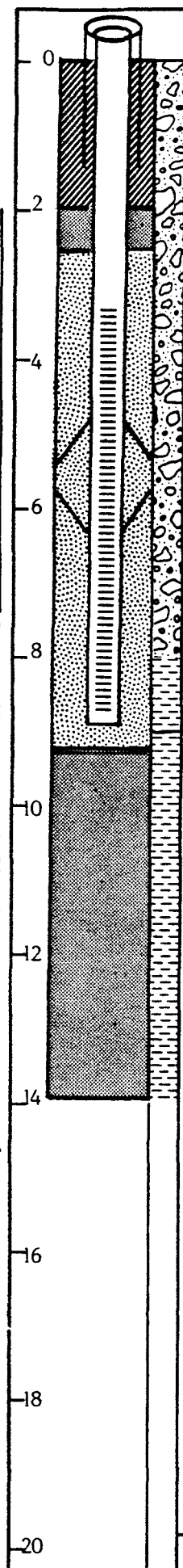
See Well Development Summary Sheet.

## COMMENTS:

No water encountered during drilling.

Top of stainless steel casing: 1.98'

 LOCATION Golden, CO  
 PERSONNEL J. Bergman

 PROJECT 106P06222  
 Rocky Flats Plant


WELL 64-86

**Hydro-Search, Inc.**      Reno • Denver

CONSULTING HYDROLOGISTS-GEOLOGISTS

## INDEX OF DATA

Boring No.: 65-86

Completed as well? Yes

### Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☒ Water Level Data

Date Drilled 9/13/86

Coordinates N 34886.7 E 24389.5

Boring Method Hollow Stem Auger

Ground Surface Elevation 5782.75

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			<p>VALLEY FILL ALLUVIUM</p> <p>0-0.4'-Sample. Recovered 0.4/0.4'=100%. CLAY: dusky yellowish brown (10YR 2/2); silty; trace of granitic pebbles; poorly sorted; unconsolidated; damp.</p> <p>0.4-0.6'-Sample. Recovered 0.2/0.2'=100%. SAND: moderate yellowish brown (10YR 5/4); medium grained sand; clayey; moderately sorted; unconsolidated; angular; damp.</p> <p>0.6-7.0'-Sample. Recovered 0.0/6.4'=0%. Cuttings. BOULDERS: granite and quartzite cobbles and boulders; wet.</p>					
	5			<p>ARAPAHOE FORMATION</p> <p>7.0-9.5'-Sample. Recovered 2.5/2.5'=100%. CLAYSTONE: light olive gray (5Y 6/1); mottled iron staining; trace plant fossils; wet.</p> <p>9.5-12.5'-Sample. Recovered 3.0/3.0'=100%. CLAYSTONE: Same as above; wet.</p>					
	10			<p>TOTAL DEPTH: 12.5'</p>					
	15								
	20								

Remarks

Logged by: L. Pivonka

Checked by: 

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 1



02/22/88

ROCKY FLATS PLANT  
WATER LEVEL DATA SUMMARY

WELL NUMBER	DATE	G. S. ELEVATION	TOC ELEVATION	STICK UP	SI BASE BELOW TOC	WATER DEPTH BELOW TOC	WATER SURFACE ELEVATION
6586	09/16/86	5782.75	5784.40	1.65	9.65	7.15	5777.25
	09/17/86	5782.75	5784.40	1.65	9.65	7.19	5777.21
	09/19/86	5782.75	5784.40	1.65	9.65	7.32	5777.08
	09/24/86	5782.75	5784.40	1.65	9.65	7.32	5777.08
	10/13/86	5782.75	5784.40	1.65	9.65	6.45	5777.95
	11/26/86	5782.75	5784.40	1.65	9.65	6.06	5778.34
	01/01/87	5782.75	5784.40	1.65	9.65	6.04	5778.36
	05/08/87	5782.75	5784.40	1.65	9.65	5.88	5778.52
	06/02/87	5782.75	5784.40	1.65	9.65	6.58	5777.82
	07/07/87	5782.75	5784.40	1.65	9.65	7.10	5777.30
	08/06/87	5782.75	5784.40	1.65	9.65	7.30	5777.10
	09/02/87	5782.75	5784.40	1.65	9.65	7.00	5777.40
	09/08/87	5782.75	5784.40	1.65	9.65	7.90	5776.50
	10/05/87	5782.75	5784.40	1.65	9.65	7.30	5777.10
	11/03/87	5782.75	5784.40	1.65	9.65	6.90	5777.50
	12/01/87	5782.75	5784.40	1.65	9.65	6.38	5778.02
	12/16/87	5782.75	5784.40	1.65	9.65	6.50	5777.90
	01/08/88	5782.75	5784.40	1.65	9.65	5.90	5778.50
	02/04/88	5782.75	5784.40	1.65	9.65	5.56	5778.84



## INDEX OF DATA

Boring No.: 66-86

Completed as well? Yes

### Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☐ Well Development Summaries
- ☐ Hydraulic Conductivity Test Data and Results
- ☐ Packer Test Data and Results
- ☒ Water Level Data

Project: Rocky Flats Plant

## LOG OF BORING NO.


66-86

Date Drilled 9/13/86

Coordinates N 33638.7 E 28151.6

Boring Method Hollow Stem Auger

Ground Surface Elevation 5685.12

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			<p>VALLEY FILL ALLUVIUM</p> <p>0-1.6'-Sample. Recovered 1.6/1.6'=100%. GRAVEL: dark yellowish brown (10YR 4/2); granitic pebbles and cobbles with coarse to fine-grained sand; clayey; poorly sorted; subangular; unconsolidated; dry.</p> <p>1.6-5.8'-Sample. Recovered 0.0/4.2'=0%. Cuttings. BOULDERS: granite and quartzite cobbles and boulders; moist.</p> <p>Wet at 4.5'</p> <p>ARAPAHOE FORMATION</p> <p>5.8-9.0'-Sample. Recovered 3.2/3.2'=100%. CLAYSTONE: light olive gray (5Y 6/1); mottled iron staining; weathered; consolidated; damp.</p> <p>9.0-12.0'-Sample. Recovered 3.0/3.0'=100%. CLAYSTONE: Same as above; damp.</p> <p>TOTAL DEPTH: 12.0'</p>					
	5								
	10								
	15								
	20								

Remarks

Logged by: L. Pivonka

Checked by: 

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 1

## WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS: \_\_\_\_\_  
 N 33638.7 E 28151.6

 ELEVATION: GROUND LEVEL 5685.12'  
 TOP OF CASING 5686.73'

## DRILLING SUMMARY:

TOTAL DEPTH Well: 6.50' Hole: 12.00'

BOREHOLE DIAMETER 7 1/4"

DRILLER Boyles Brothers Drilling Co.

15865 W. 5th Avenue

Golden, CO (Jim Horn)

RIG Mobile B-57

BIT(S) Blade bit

DRILLING FLUID None

SURFACE CASING 5" x 4' steel w/ locking cap

## WELL DESIGN:

BASIS: GEOLOGIC LOG X GEOPHYSICAL LOG \_\_\_\_\_

CASING STRING(S): C=CASING S=SCREEN

0.00'	2.50'	C1	_____	_____
2.50'	6.50'	S1	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____
_____	_____	_____	_____	_____

CASING: C1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed.

SCREEN: S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0.010" wire wrap screen 0.25' welded bottom cap.

CENTRALIZERS Type 304 stainless steel 3.68' - 4.88'

FILTER MATERIAL 32-42 silica sand 2.00' - 6.80'

CEMENT Portland Type I 0.00' - 1.50'

OTHER 3/8" bentonite pellets

1.50' - 2.00'

6.80' - 12.00'

## CONSTRUCTION TIME LOG:

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING:	1986		1986	
7 1/4" auger	9/13	1630	9/13	1706
GEOPHYS. LOGGING:	—	—	—	—
CASING:				
2" stainless	9/15	0924	9/15	0925
FILTER PLACEMENT:	9/15	0925	9/15	0933
CEMENTING:	9/15	0935	9/15	0945
DEVELOPMENT:	9/22	1315	9/24	1551
OTHER:				
Bentonite	9/15	0933	9/15	0935
	9/15	0920	9/15	0924

## WELL DEVELOPMENT

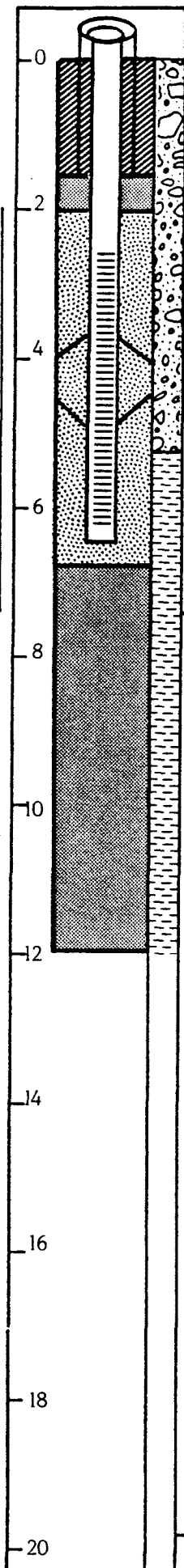
See Well Development Summary Sheet.

## COMMENTS:

Water encountered at 4.5' during drilling.

Top of stainless steel casing: 1.61'

 LOCATION Golden, CO  
 PERSONNEL L. Pivonka

 PROJECT 106P06222  
 Rocky Flats Plant


02/22/88

ROCKY FLATS PLANT  
WATER LEVEL DATA SUMMARY

WELL NUMBER	DATE	G. S. ELEVATION	TOC ELEVATION	STICK UP	SI BASE BELOW TOC	WATER DEPTH BELOW TOC	WATER SURFACE ELEVATION
6686	09/22/86	5685.12	5686.73	1.61	8.11	7.25	5679.48
	09/23/86	5685.12	5686.73	1.61	8.11	7.35	5679.38
	09/23/86	5685.12	5686.73	1.61	8.11	7.24	5679.49
	09/24/86	5685.12	5686.73	1.61	8.11	7.27	5679.46
	09/25/86	5685.12	5686.73	1.61	8.11	7.83	5678.90
	10/13/86	5685.12	5686.73	1.61	8.11	5.36	5681.37
	11/03/86	5685.12	5686.73	1.61	8.11	5.00	5681.73
	11/26/86	5685.12	5686.73	1.61	8.11	4.74	5681.99
	01/01/87	5685.12	5686.73	1.61	8.11	4.46	5682.27
	05/08/87	5685.12	5686.73	1.61	8.11	4.83	5681.90
	06/02/87	5685.12	5686.73	1.61	8.11	4.45	5682.28
	07/07/87	5685.12	5686.73	1.61	8.11	5.40	5681.33
	07/17/87	5685.12	5686.73	1.61	8.11	-1.00	DRY
	08/06/87	5685.12	5686.73	1.61	8.11	7.30	5679.43
	09/02/87	5685.12	5686.73	1.61	8.11	7.20	5679.53
	09/08/87	5685.12	5686.73	1.61	8.11	7.90	5678.83
	10/01/87	5685.12	5686.73	1.61	8.11	6.20	5680.53
	11/03/87	5685.12	5686.73	1.61	8.11	5.00	5681.73
	12/01/87	5685.12	5686.73	1.61	8.11	4.77	5681.96
	12/16/87	5685.12	5686.73	1.61	8.11	4.90	5681.83
	01/08/88	5685.12	5686.73	1.61	8.11	-1.00	DRY
	02/04/88	5685.12	5686.73	1.61	8.11	4.37	5682.36

## INDEX OF DATA

Boring No.: 68-86

Completed as well? Yes

### Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☒ Well Development Summaries
- ☒ Hydraulic Conductivity Test Data  
and Results
- ☐ Packer Test Data and Results
- ☒ Water Level Data

Project: Rocky Flats Plant

## LOG OF BORING NO. 68-86

Date Drilled 9/10/86

Coordinates N 34173.0 E 20466.1

Boring Method Hollow Stem Auger

Ground Surface Elevation 5880.75

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch) 20 40	Water Content (%) 20 40	Other Tests
	0			<b>VALLEY FILL ALLUVIUM</b>  0-0.9'-Sample. Recovered 0.7/0.9'=78%. GRAVEL: dusky yellowish brown (10YR 2/2); granitic pebbles and cobbles; some sand and silt; poorly sorted; unconsolidated; moist.  0.9-2.0'-Sample. Recovered 0.0/1.1'=0%. Cuttings. COBBLES: quartzite, wet.  2.0-2.8'-Sample. Recovered 0.8/0.8'=100%. GRAVEL: dark yellowish brown (10YR 4/2); granite and quartzite pebbles and cobbles with sand and silt; poorly sorted; unconsolidated; wet.			
	5			<b>ARAPAHOE FORMATION</b>  2.8-7.0'-Sample. Recovered 1.7/3.9'=44%. CLAYSTONE: pale yellowish brown (10YR 6/2); silty; some iron staining; weathered; moist.  7.0-9.0'-Sample. Recovered 2.0/2.0'=100%. CLAYSTONE: Same as above; moist.			
	10			<b>TOTAL DEPTH: 9.0'</b>			
	15						
	20						

Remarks

Logged by: L. Pivonka

Checked by: *SLP*

Project No.

106P06222

Hydro-Search, Inc.

Page 1 of 1



**WELL**

**68-86**

[illegible]



## AQUIFER TEST DATA

WELL 68-86

Type of Aquifer Test: Bail down - Recovery  
 How Q Measured: 4.5 gallon bucket  
 How W.L.'s Measured: Olympic Well Sounder  
 Measuring Point for W.L.'s: Top of Casing  
 Elevation of Measuring Point: 5895.74

Project No.: 106P06222  
 Location: Rocky Flats Plant  
 Personnel: W. Herst, D. Pavlick

Depth of pump/airline: N/A

Start bailing: 9/29/86 Time: 1230:00

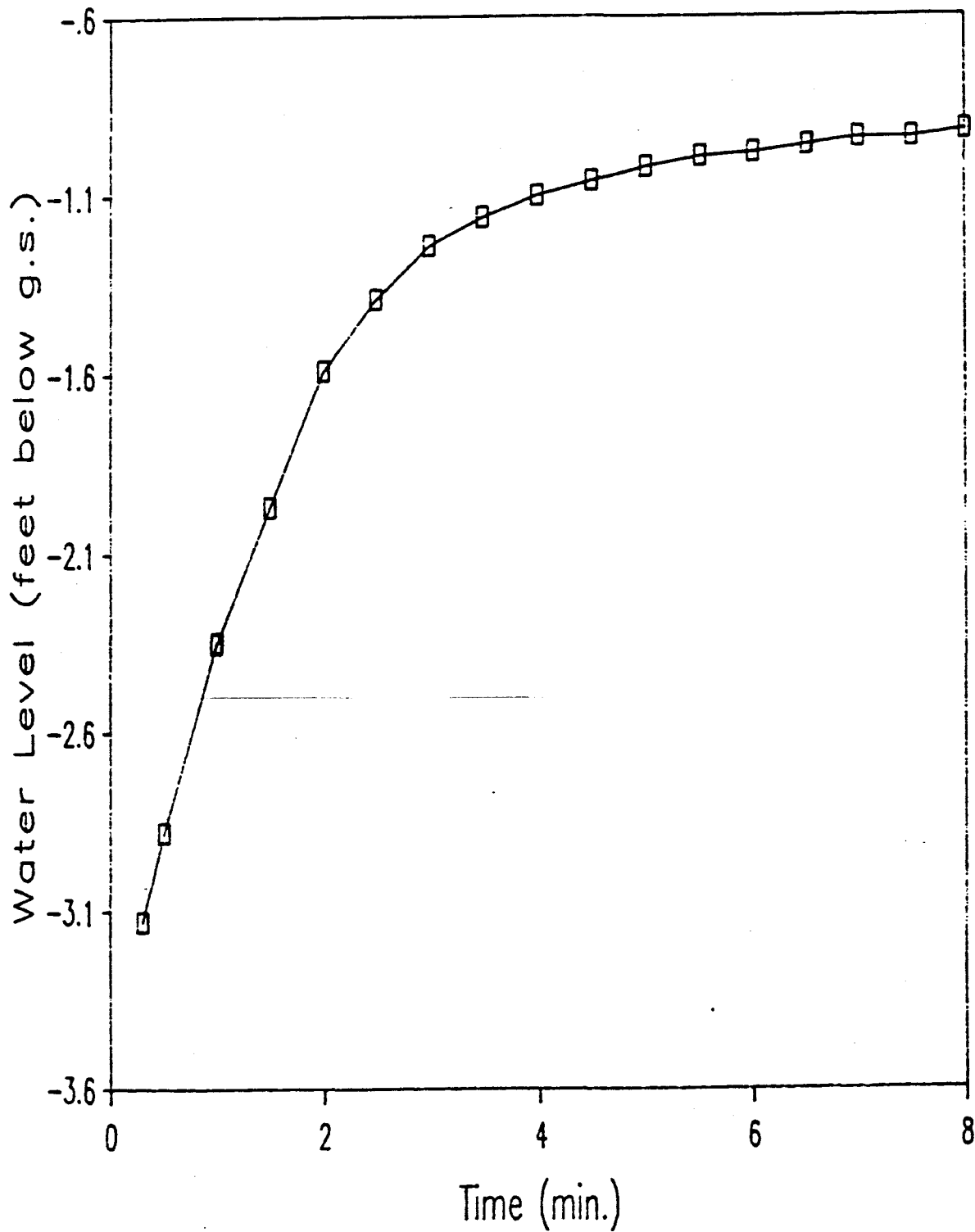
Stop bailing: 9/29/86 Time: 1240:00

Duration of Aquifer Test: 10.0 minutes

TIME		WATER LEVEL DATA		COMMENTS
t = 2	at t' = 0	Static Water Level: .92		
t	t'	Water Level	Draw-down	
0		.92		Begin bailing
2.0	0			Stop bailing
2.3	.3	3.13	2.21	
2.5	.5	2.88	1.96	
3.0	1.0	2.35	1.43	Total depth = 3.6'
3.5	1.5	1.97	1.05	
4.0	2.0	1.59	.67	
4.5	2.5	1.39	.47	
5.0	3.0	1.24	.32	
5.5	3.5	1.16	.24	
6.0	4.0	1.10	.18	
6.5	4.5	1.06	.14	
7.0	5.0	1.02	.10	
7.5	5.5	.99	.07	
8.0	6.0	.98	.06	
8.5	6.5	.96	.04	
9.0	7.0	.94	.02	
9.5	7.5	.94	.02	
10.0	8.0	.92	.00	100% recovered

# AQUIFER TEST DATA

WELL 68-86



02/22/88

ROCKY FLATS PLANT  
WATER LEVEL DATA SUMMARY

WELL NUMBER	DATE	G. S. ELEVATION	TOC ELEVATION	STICK UP	SI BASE BELOW TOC	WATER DEPTH BELOW TOC	WATER SURFACE ELEVATION
-----	-----	-----	-----	-----	-----	-----	-----
6886	09/13/86	5880.75	5883.77	3.02	6.52	4.54	5879.23
	09/17/86	5880.75	5883.77	3.02	6.52	3.87	5879.90
	09/19/86	5880.75	5883.77	3.02	6.52	3.89	5879.88
	09/22/86	5880.75	5883.77	3.02	6.52	3.81	5879.96
	10/13/86	5880.75	5883.77	3.02	6.52	3.38	5880.39
	11/26/86	5880.75	5883.77	3.02	6.52	3.30	5880.47
	01/01/87	5880.75	5883.77	3.02	6.52	3.08	5880.69
	05/08/87	5880.75	5883.77	3.02	6.52	3.40	5880.37
	06/02/87	5880.75	5883.77	3.02	6.52	3.73	5880.04
	06/24/87	5880.75	5883.77	3.02	6.52	4.20	5879.57
	07/07/87	5880.75	5883.77	3.02	6.52	3.90	5879.87
	07/14/87	5880.75	5883.77	3.02	6.52	4.00	5879.77
	08/06/87	5880.75	5883.77	3.02	6.52	-1.00	DRY
	09/02/87	5880.75	5883.77	3.02	6.52	3.40	5880.37
	10/06/87	5880.75	5883.77	3.02	6.52	3.30	5880.47
	11/10/87	5880.75	5883.77	3.02	6.52	3.30	5880.47
	12/18/87	5880.75	5883.77	3.02	6.52	3.40	5880.37
	01/09/88	5880.75	5883.77	3.02	6.52	-1.00	DRY
	02/04/88	5880.75	5883.77	3.02	6.52	-1.00	DRY

## INDEX OF DATA

Boring No.: 69-86

Completed as well? Yes

### Data in File

- ☒ Log of Borehole
- ☒ Well Construction Summaries
- ☒ Well Development Summaries
- ☒ Hydraulic Conductivity Test Data  
and Results
- ☐ Packer Test Data and Results
- ☒ Water Level Data

Project: Rocky Flats Plant

## LOG OF BORING NO. 69-86

Date Drilled 9/24/86

Coordinates N 34786.4 E 21168.0

Boring Method Hollow Stem Auger

Ground Surface Elevation 5915.42

Elev. (feet)	Depth (feet)	Sample Type	Graphic Log	Material Description	Penetration Resistance (Blows/Inch)		Water Content (%)		Other Tests
					20	40	20	40	
	0			COLLUVIUM					
				0-0.5'-Sample. Recovered 0.5/0.5'=100%. CLAY: dark yellowish brown (10YR 4/2) and moderate yellowish brown (10YR 5/4); micaceous; silty; trace granitic pebbles; poorly sorted; unconsolidated; damp.					
	5			0.5-4.9'-Sample. Recovered 4.4/4.4'=100%. CLAY: Same as above; damp to moist.			▽		
				4.9-7.0'-Sample. Recovered 2.1/2.1'=100%. CLAY: Same as above; moist.					
				7.0-8.0'-Sample. Recovered 1.0/1.0'=100%. CLAY: Same as above; moist.					
	10			8.0-10.0'-Sample. Recovered 2.0/2.0'=1000%. CLAY: Same as above with some granitic cobbles; moist.			▽		
				10.0-11.0'-Sample. Recovered 0.0/1.0'=0%.					
				11.0-12.5'-Split Spoon. Recovered 1.0/1.5'=67%. GRAVEL: light brown (5YR 5/6) and dark yellowish orange (10YR 6/6); granitic pebbles and cobbles; clayey; poorly sorted; unconsolidated; wet.					
	15			12.5-13.3'-Split Spoon. Recovered 0.8/0.8'=100%. GRAVEL: Same as above; wet.					
				ARAPAHOE FORMATION					
				13.3-17.5'-Sample. Recovered 4.2/4.2'=100%. CLAYSTONE: light olive gray (5Y 6/1) and dark yellowish orange; consolidated; moist.					
	20			TOTAL DEPTH: 17.5'					

Remarks

Logged by: L. Pivonka

Checked by: *[Signature]*Project No.  
106P06222

Hydro-Search, Inc.

Page 1 of 1

## WELL CONSTRUCTION SUMMARY

 LOCATION or COORDS: \_\_\_\_\_  
 N 34786.4 E 21168.0

 ELEVATION: GROUND LEVEL 5915.42'  
 TOP OF CASING 5916.43'

## DRILLING SUMMARY:

TOTAL DEPTH Well: 14.00' Hole: 17.40'

BOREHOLE DIAMETER 7 1/4"

DRILLER Boyles Brothers Drilling Co.

15865 W. 5th Avenue

Golden, CO (Jim Horn)

RIG Mobile B-57

BIT(S) Blade bit

DRILLING FLUID None

SURFACE CASING 5" x 4' steel w/ locking cap

## WELL DESIGN:

BASIS: GEOLOGIC LOG X GEOPHYSICAL LOG \_\_\_\_\_

CASING STRING(S): C=CASING S=SCREEN

0.00' 3.00' C1

3.00' 14.00' S1

CASING: C1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed.

SCREEN: S1 2" I.D. Sch. 5 type 316 stainless steel, threaded and flush jointed, 0.010" wirewrap screen, 0.25' welded bottom cap.

CENTRALIZERS Type 304 stainless steel  
8.33' - 9.52'FILTER MATERIAL 32-42 silica sand  
2.50' - 14.30'CEMENT Portland Type I  
0.00' - 2.00'OTHER 3/8" bentonite pellets  
2.00' - 2.50'  
14.30' - 17.40'

## CONSTRUCTION TIME LOG:

TASK	START		FINISH	
	DATE	TIME	DATE	TIME
DRILLING:	1986		1986	
7 1/4" auger	9/24	1424	9/24	1630
GEOPHYS. LOGGING:				
CASING:				
2" stainless	9/24	1644	9/24	1645
FILTER PLACEMENT:	9/24	1645	9/24	1705
CEMENTING:	9/24	1707	9/24	1712
DEVELOPMENT:	9/30	1555	10/8	0845
OTHER:				
Bentonite	9/24	1705	9/24	1707
	9/24	1642	9/24	1644

## WELL DEVELOPMENT

See Well Development Summary Sheet.

## COMMENTS:

Water encountered at 10.0' during drilling

Top of stainless steel casing: 1.01'

WELL 69-86

**Hydro-Search, Inc.**      Reno • Denver

**CONSULTING HYDROLOGISTS-GEOLOGISTS**

PROGRAM SLUGT. VERSION 4.OCT. 1985

THIS PROGRAM CALCULATES MEAN TRANSMISSIVITIES FROM SLUG-TEST DATA BASED ON TWO ANALYTICAL APPROACHES:

- (1) METHOD OF COOPER, BREDEHOEFT AND PAPADOPULOS, 1967 (ARTICLE IN VOL.3,NO.1 OF WRR ENTITLED "RESPONSE OF A FINITE DIAMETER WELL TO AN INSTANTANEOUS CHARGE OF WATER")
- (2) METHOD OF BOUWER AND RICE, 1976 (ARTICLE IN VOL. 12, NO.3 OF WRR ENTITLED "A SLUG TEST FOR DETERMINING HYDRAULIC CONDUCTIVITY OF UNCONFINED AQUIFERS WITH COMPLETELY OR PARTIALLY PENETRATING WELLS")

PROJECT NO.: 6-011B-87

CLIENT: Rockwell International

ITE LOCATION: Rocky Flats Plant

DATE OF SLUG TEST: 10-26-87

FIELD INVESTIGATOR: Kevin McNeill

WELL NO.: 69-86

INPUT DATA ARE:

INNER CASING DIAMETER = 2.00 INCHES

LENGTH OF SCREEN OR INTAKE PORTION = 7.32 FEET

INNER SCREEN OR OPEN-HOLE DIAMETER = 2.00 INCHES

DEPTH FROM STATIC LEVEL TO BOTTOM OF SCREEN = 7.32 FEET

DIAMETER OF DRILLED HOLE = 7.25 INCHES

THICKNESS OF SATURATED AQUIFER ZONE = 7.32 FEET



ESTIMATED POROSITY OF GRAVEL PACK = .25

FALLING-HEAD INDEX = 0 ("1" IF FALLING, "0" IF RISING)

NUMBER OF HEAD-TIME DATA POINTS = 36

TIME (sec )	HEAD (FEET)
1.00	.310
2.00	.300
3.00	.290
4.00	.280
5.00	.270
6.00	.260
7.00	.250
8.00	.240
9.00	.240
10.00	.230
12.00	.220
15.00	.200
17.00	.190
20.00	.180
22.00	.170
25.00	.160
30.00	.150
35.00	.140
40.00	.130
45.00	.120
50.00	.110
62.00	.100
72.00	.090
82.00	.090
92.00	.090
122.00	.090
152.00	.080
182.00	.080
262.00	.080
322.00	.080
442.00	.070
562.00	.070
802.00	.060
1042.00	.060
1282.00	.060
1702.00	.050

H0 WAS COMPUTED FROM INTERCEPT OF PLOT OF LOG(H) VS. TIME

SUCCESSIVE COMPUTED  
VALUES FOR H0  
(FEET)

.1648

.1690

\*\*\*\*\*

METHOD OF BOUWER AND RICE

COMPUTED RESULTS USING DIAMETER OF DRILLED HOLE:

PERMEABILITY =  $5.70\text{E-}06$  FT/sec      =  $1.74\text{E-}04$  CM/sec

TRANSMISSIVITY =  $4.17\text{E-}05$  FT\*\*2/sec

COMPUTED RESULTS USING DIAMETER OF CASING AND SCREEN:

PERMEABILITY =  $2.05\text{E-}06$  FT/sec      =  $6.24\text{E-}05$  CM/sec

TRANSMISSIVITY =  $1.50\text{E-}05$  FT\*\*2/sec

WELL NO.: 69-86

INPUT DATA ARE:

## AQUIFER TEST DATA

WELL 69-86

Type of Aquifer Test: Bail down - Recovery      Project No.: 106P06222  
 How Q Measured: 4.5 gallon bucket      Location: Rocky Flats Plant  
 How W.L.'s Measured: Olypic Well Sounder      Personnel: J. Pearce, M. Bergaan  
 Measuring Point for W.L.'s: Top of Casing  
 Elevation of Measuring Point:

Depth of pump/airline:

Start bailing:      Time: 1130:00

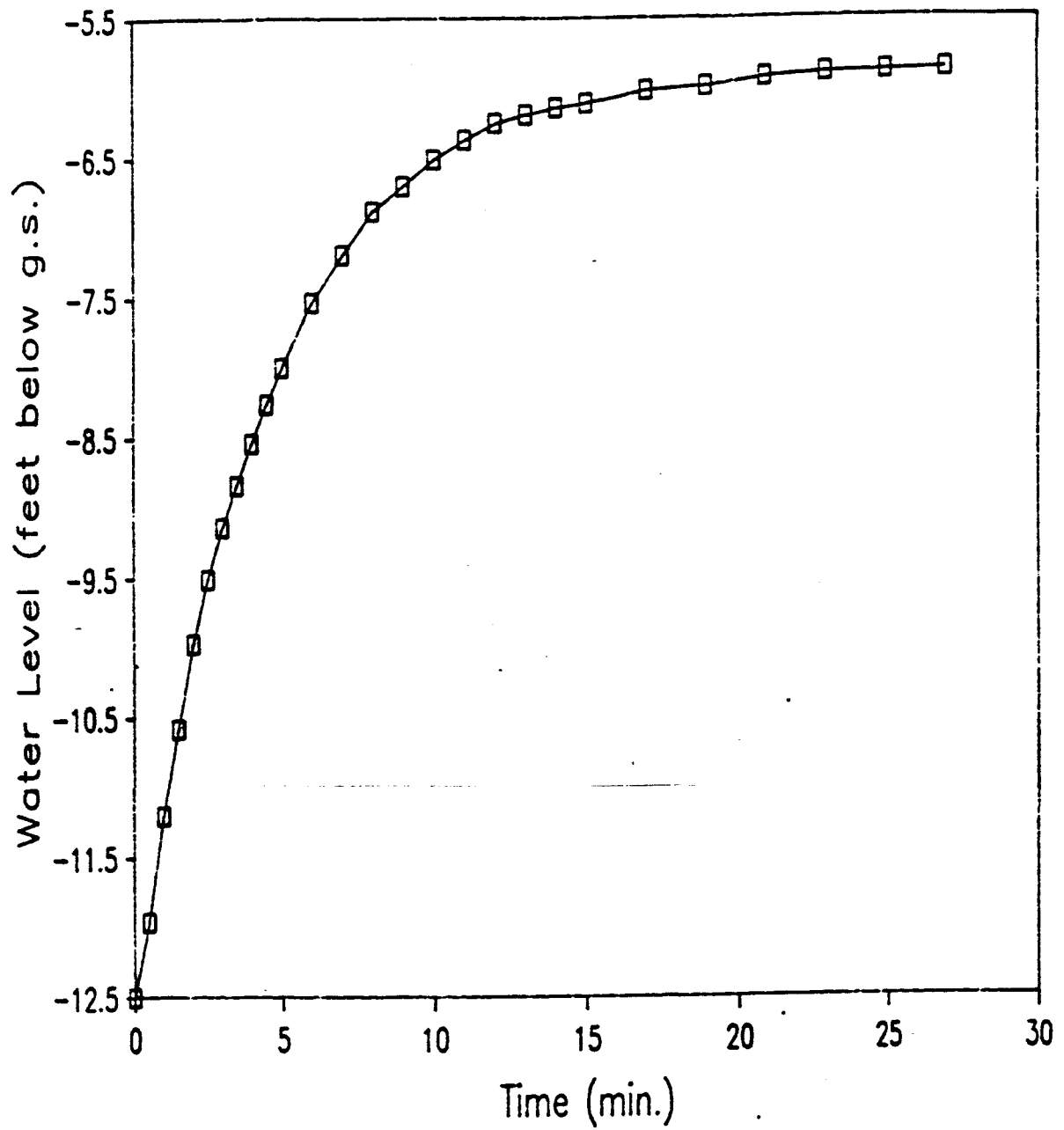
Stop bailing:      Time: 1145:00

Duration of Aquifer Test: 42 minutes

TIME		WATER LEVEL DATA		COMMENTS
t = 15 min	at t' = 0	Static Water Level: 5.70'		
t	t'	Water Level	Draw-down	
0				Begin bailing
15.0	0	12.50	6.80	Stop bailing
15.5	.5	11.96	6.26	
16.0	1.0	11.20	5.50	
16.5	1.5	10.58	4.88	
17.0	2.0	9.97	4.27	
17.5	2.5	9.51	3.81	
18.0	3.0	9.14	3.44	
18.5	3.5	8.84	3.14	
19.0	4.0	8.54	2.84	
19.5	4.5	8.26	2.56	
20.0	5.0	8.00	2.30	
21.0	6.0	7.53	1.83	
22.0	7.0	7.19	1.49	
23.0	8.0	6.88	1.18	
24.0	9.0	6.70	1.00	
25.0	10.0	6.51	.81	
26.0	11.0	6.37	.67	90% Recovered at
27.0	12.0	6.25	.55	6.38'
28.0	13.0	6.19	.49	
29.0	14.0	6.14	.44	
30.0	15.0	6.11	.41	
32.0	17.0	6.02	.32	
34.0	19.0	5.99	.29	
36.0	21.0	5.93	.23	
38.0	23.0	5.90	.20	
40.0	25.0	5.89	.19	
42.0	27.0	5.88	.18	

# AQUIFER TEST DATA

WELL 69-86



02/22/88

ROCKY FLATS PLANT  
WATER LEVEL DATA SUMMARY

WELL NUMBER	DATE	G. S. ELEVATION	TOC ELEVATION	STICK UP	SI BASE BELOW TOC	WATER DEPTH BELOW TOC	WATER SURFACE ELEVATION
6986	09/30/86	5921.19	5922.64	1.45	15.45	7.31	5915.33
	10/02/86	5921.19	5922.64	1.45	15.45	7.39	5915.25
	10/03/86	5921.19	5922.64	1.45	15.45	7.37	5915.27
	10/06/86	5921.19	5922.64	1.45	15.45	7.44	5915.20
	10/08/86	5921.19	5922.64	1.45	15.45	7.45	5915.19
	10/13/86	5921.19	5922.64	1.45	15.45	6.83	5915.81
	11/26/86	5921.19	5922.64	1.45	15.45	5.70	5916.94
	01/01/87	5921.19	5922.64	1.45	15.45	5.00	5917.64
	05/07/87	5921.19	5922.64	1.45	15.45	1.44	5921.20
	06/02/87	5921.19	5922.64	1.45	15.45	2.35	5920.29
	06/24/87	5921.19	5922.64	1.45	15.45	2.70	5919.94
	07/06/87	5921.19	5922.64	1.45	15.45	1.80	5920.84
	08/06/87	5921.19	5922.64	1.45	15.45	3.80	5918.84
	09/02/87	5921.19	5922.64	1.45	15.45	2.90	5919.74
	10/05/87	5921.19	5922.64	1.45	15.45	4.70	5917.94
	11/09/87	5921.19	5922.64	1.45	15.45	4.60	5918.04
	12/16/87	5921.19	5922.64	1.45	15.45	3.30	5919.34
	01/09/88	5921.19	5922.64	1.45	15.45	2.90	5919.74
	02/04/88	5921.19	5922.64	1.45	15.45	2.27	5920.37